



# **Volume 2 of 2 Project Manual**

**DEEP West District Headquarters  
Black Rock State Park  
2065 Thomaston Road  
Watertown, CT  
Project No.: BI-T-615**

**Prepared By:  
TLB Architecture, LLC  
92 West Main Street  
Chester, Connecticut  
06412**

**Josh Geballe – Commissioner**

**State of Connecticut  
Department of Administrative Services  
Construction Services  
450 Columbus Boulevard  
Hartford, CT 06103**

**Project Manual Date: May 15, 2020**



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## DIVISION 00 PROCUREMENT AND CONTRACTING REQUIREMENTS

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SECTION 210400 GENERAL CONDITIONS FOR FIRE SUPPRESSION TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 21, "Fire Suppression" of this project specification unless specified otherwise in the individual sections.
- C. Products shall be FM Approved where listed by Factory Mutual and installation shall be in accordance with FM Global Property Loss Prevention Data Sheets.
- D. All new sprinkler protection should be installed per FM Global Data Sheet 2.0, Installation Guidelines for Automatic Sprinklers.
- E. Section 01 91 13 - General Commissioning Requirements.
- F. Section 017419 - Construction and Demolition Waste Management and Disposal.
- G. Section 018113 - Sustainable Design Requirements.
- H. Section 018119 - Construction Indoor Air Quality Requirements.

1.2 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.
- B. LEED v4 Submittals: For all interior, wet-applied adhesives, sealants, paints and coatings related to the work of this Section, submit product and material documentation as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

1.3 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.
- C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.
- D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.4 DEFINITIONS

- A. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.
- B. "Approved equal" mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.
- C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.
- D. "Finished" refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.
- E. "Furnish" or "supply" shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.
- F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.

- G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.
- H. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
- I. “Provide” shall mean furnish (or supply) and install as necessary.
- J. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- K. Remove: The term “remove” means “ to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”
- L. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.
- M. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- N. “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.
- O. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."
- P. “Wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

#### 1.5 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)
- B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.
- C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.

- D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

## 1.6 CODES AND STANDARDS

- A. Reference Standard Compliance
1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
  2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- B. The Following Codes and Standards listed below apply to all fire protection work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition shall be followed:
- Connecticut State Building Code Including all Supplements
  - Connecticut State Fire Safety Code Including all Supplements
  - Connecticut Building Standards Guidelines – Compliance for High Performance Buildings
  - The International Building Code
  - The International Mechanical Code
  - The International Plumbing Code
  - The International Energy Conservation Code
  - The National Electrical Code
  - NFPA 13
  - ASHRAE 90.1 and International Energy Conservation Code
- C. The following Standards shall be used where referenced by the following abbreviations:
- |       |   |
|-------|---|
| ACGIH | American Conference of Governmental Industrial Hygienists |
| AIA   | American Institute of Architects                          |
| ANSI  | American National Standards Institute                     |
| ASME  | American Society of Mechanical Engineers                  |
| ASPE  | American Society of Plumbing Engineers                    |
| ASSE  | American Society of Sanitary Engineers                    |
| ASTM  | American Society of Testing and Materials                 |
| AWS   | American Welding Society                                  |
| AWWA  | American Water Works Association                          |
| CISPI | Cast Iron Soil Pipe Institute                             |
| EJMA  | Expansion Joint Manufacturing Association                 |
| EPA   | Environmental Protection Agency                           |
| FM    | Factory Mutual  |
| FSSC  | Federal Specification                                     |

HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
MCAA	Mechanical Contractors Association of America
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STI	Steel Tank Institute
UL	Underwriters' Laboratories

- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.
1. The contractor shall review all published design guides and recommendations of the owner's insurance underwriter, FM Global. Contractor shall include documented criteria which is above and beyond local codes in their bid.
- E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

#### 1.7 PERMITS AND FEES

- A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

#### 1.8 EQUIPMENT SUBSTITUTIONS

- A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The contractor is required to submit any and all costs (including costs associated or required by all trades)

along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.

- B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.
- C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.
- D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.
- E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.
- F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.
- G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
  - 1. The equivalent shall have the same construction features such as, but not limited to:
    - a. Material thickness, gauge, weight, density, etc.
    - b. Welded, riveted, bolted, etc., construction
    - c. Finish, undercoating, corrosion protection
  - 2. The equivalent shall perform with the same or better operating efficiency.
  - 3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  - 4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.



- H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
  2. Submit three (3) copies of each request for substitution for consideration.
  3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
    - b. Samples, where applicable or requested.
    - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
    - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
    - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
    - f. Cost information, including a proposal of the net change, if any in the Contract Sum.
    - g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
    - h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
    - i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
      - 1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.

- 2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
- 3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

#### 1.9 SUBMITTAL PROCEDURES

- A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
  1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
  2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
  1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
  2. If an intermediate submittal is necessary, process the same as the initial submittal.
  3. Allow two weeks for reprocessing each submittal.
  4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
  1. Include the following information on the label for processing and recording action taken.
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.



- g. Name of manufacturer.
  - h. Number, title and paragraph of appropriate Specification Section.
  - i. Drawing number and detail references, as appropriate.
- E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.
- F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.
- G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

#### 1.10 SHOP DRAWINGS

- A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to Division 1 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.
- C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.
- D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.

- E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- G. "No Exception Taken" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.
- H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.
- I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.
- K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.
- L. Prepare sprinkler shop drawings drawn in the latest AutoCAD version to a minimum scale of 1/4" = 1' - 0". Final approved drawings shall be turned over to the Owner on CD Rom, flash drive or other electronic version.

#### 1.11 COORDINATION DRAWINGS

- A. Prepare coordination drawings drawn in the latest AutoCAD and BIM versions in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
    - a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
    - b. Equipment connections and support details.
    - c. Exterior wall and foundation penetrations.
    - d. Fire-rated wall and floor penetrations.

- e. Sizes and locations of required concrete pads and bases.
- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.
- F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.
- G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files a Electronic Drawing File Release Form must be submitted. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic Drawing File Release Form, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the Electronic Drawing File Release Form is appended to the end of this specification section

#### 1.12 COORDINATION WITH OTHER DIVISIONS

- A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.
- B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.
- C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.
- D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

1.13 WORKMANSHIP

- A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
- B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.
- D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- E. All labor for installation of plumbing systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.14 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.
- B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.15 TEMPORARY UTILITIES

- A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. First Aid Supplies: Comply with governing regulations.
- D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
- E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
  - 1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
- F. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building's permanent HVAC systems shall not be used for these purposes.
- G. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.
- H. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.16 PROJECT PHASING

- A. Work under each Section shall include all necessary temporary connections, equipment, piping, fire stopping, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

1.17 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

1.18 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Prior to testing, Owner and Cx agent shall be notified 1 week in advance of testing.
- C. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing, that the equipment was installed according to manufacturers recommendations and is operating as intended by the manufacturer.



1.19 CLEANING

- A. The Contractor shall thoroughly clean and flush all piping and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.
- B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.
- C. During the course of construction, all pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.
- E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
  - 1. Remove labels that are not permanent labels.
  - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
  - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
  - 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
- F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.
- G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

1.20 OPERATING AND MAINTENANCE

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.

- B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: alarm check valves, compressors, etc. These letters shall be bound into the operating and maintenance books.
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

#### 1.21 OPERATING AND MAINTENANCE MANUALS

- A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.
- B. Manual shall include the following:
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing and operating instructions including lubrication charts and schedules.
  - 5. Emergency and safety instructions.
  - 6. Spare parts list.
  - 7. Copies of warranties.
  - 8. Wiring diagrams.
  - 9. Recommended "turn around" cycles.
  - 10. Inspection procedures.
  - 11. Approved Shop Drawings and Product Data.
  - 12. Equipment Start-up Reports.
  - 13. Written sequences of operations.
- C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.



- D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

#### 1.22 ACCEPTANCES

- A. The equipment, materials, workmanship, design and arrangement of all work installed under the Fire Protection Sections shall be subject to the review of the Engineer.
- B. Within 30 days after the awarding of a Contract, the Sprinkler Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Fire Protection Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner's representative.
- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Fire Protection Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

#### 1.23 RECORD DRAWINGS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.
- B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
  - 1. Dimensional change

2. Revision to drawing detail
  3. Location and depth of underground utility
  4. Revision to pipe routing
  5. Revision to electrical circuitry
  6. Actual equipment location
  7. Pipe size and routing
  8. Location of concealed internal utility
  9. Changes made by Change Order
  10. Details not on original Contract Drawing
  11. Information on concealed elements which would be difficult to identify or measure later
- C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
- D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
- E. Note related Change Order numbers where applicable.
- F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
- G. Contractor shall be responsible for making all corrections in ACAD. Final record documents shall be prepared in the latest AutoCAD version. CD Rom, flash drive or other electronic version of all drawings and a clean set of hard copies shall be turned over to the Owner at the completion of the work.

#### 1.24 WARRANTIES AND BONDS

- A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
1. General close-out requirements included in Section 01 78 30 Warranties and Bonds.
  2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-2 through -50.
  3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

- D. The contractor shall guarantee all materials and workmanship for a period of eighteen (18) months from the date of Substantial Completion of the Work. In addition, the Contractor shall furnish warranties listed. Submit four (4) copies of each to the Construction Administrator in the supplier's standard form or in the form given if there is no standard form available.

#### 1.25 WARRANTY REQUIREMENTS

- A. **Related Damages and Losses:** When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. **Reinstatement of Warranty:** When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. **Replacement Cost:** Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. **Owner's Recourse:** Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. **Rejection of Warranties:** The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.
- H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

- I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
  - 1. Refer to individual Sections of Divisions-2 through -16 for specific content requirements, and particular requirements for submittal of special warranties.
  
- J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  
- K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
  - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
  - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
  - 3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

#### 1.26 GUARANTEES

- A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.
  
- B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

#### 1.27 PROJECT CLOSE-OUT

- A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.
  
- B. DEEP Equipment Forms: In addition to standard cut sheets for equipment, provide separate listing of all equipment along with tag, description, capacity ratings, model #, Serial #, etc. Forms shall be submitted electronically in spread sheet format
  
- C. Deliver tools, spare parts, extra stock, and similar items.

- D. Complete start-up testing of systems, including measuring and documenting all required startup checklist requirements documented in installation and maintenance instructions by the equipment manufacturer, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- E. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- F. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
  - 1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
  - 2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION 210400

**Electronic Drawing File Release Form**

DELIVERY OF ELECTRONIC FILES FOR: \_\_\_\_\_  
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ Client's Signature	_____ Date
_____ Company - Title	
_____ Architects' Signature	_____ Date
_____ Firm - Title	
_____ Owner's Signature	_____ Date
_____ Company - Title	

SECTION 210500 COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes pipe, fittings, and accessories for sprinkler systems.
- B. Related Sections:
  - 1. Division 3 - Concrete Forming and Accessories: Execution requirements for placement of sleeves in concrete forms specified by this section.
  - 2. Division 7 - Firestopping: Product requirements for firestopping for placement by this section.
  - 3. Division 7 - Joint Protection: Product requirements for sealant materials for placement by this section.
  - 4. Division 9 - Painting and Coating: Execution requirements for piping painting specified by this section.
  - 5. Section 21 04 00 – General Conditions for Fire Suppression Trades
  - 6. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Piping.
  - 7. Section 21 05 48 – Vibration and Seismic Controls for Fire-Suppression Piping and Equipment.
  - 8. Section 21 13 13 – Wet-Pipe Sprinkler System.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
  - 2. ASME B16.3 – Malleable Iron Threaded Fittings, Class 150 and 300.
  - 3. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
  - 4. ASME B16.5 - Pipe Flanges and Flanged Fittings
  - 5. ASME B16.9 – Factory-made Wrought Steel Butt Welding Fittings.
  - 6. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
  - 7. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
  - 8. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - 9. ASME B16.25 – Butt Welding Ends.
  - 10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
  - 11. ASME Sec 9 - Welding and Brazing Qualifications.
- B. American Society of Sanitary Engineers:
  - 1. ASSE 1013 – Standard for Reduced Pressure Principal Backflow Preventer
  - 2. ASSE 1015 – Standard for Double Check Backflow Preventer Assembly
  - 3. ASSE 1047 – Standard for Reduced Pressure Detector Backflow Preventer
  - 4. ASSE 1048 – Standard for Double Check Detector Assembly Backflow Preventer.

- C. ASTM International:
  - 1. ASTM A47 – Malleable Iron Castings.
  - 2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 3. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.
  - 4. ASTM A536 – Standard for Ductile Iron Casting.
  - 5. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
  - 6. ASTM B32 - Standard Specification for Solder Metal.
  - 7. ASTM B75 - Standard Specification for Seamless Copper Tube.
  - 8. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
  - 9. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
  
- D. American Welding Society:
  - 1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
  - 2. AWS D1.1 - Structural Welding Code - Steel.
  - 3. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
  
- E. American Water Works Association:
  - 1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
  - 2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  - 3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
  - 4. AWWA C511 – Standard for Reduced Pressure Principal Backflow Prevention Assembly.
  - 5. AWWA C606 – Standard for Grooved and Shouldered Joints.
  
- F. National Fire Protection Association:
  - 1. NFPA 10 - Portable Fire Extinguishers.
  - 2. NFPA 13 - Installation of Sprinkler Systems.
  - 3. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.
  
- G. Underwriter Laboratories, Inc.:
  - 1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.
  - 2. UL - Fire Resistance Directory.
  
- H. Factory Mutual:
  - 1. FM - Factory Mutual Approval Guide.



1.3 SUBMITTALS

- A. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- B. Product Data: Submit manufacturer's catalogue information. Provide data on piping and fittings, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Division 1 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and tag numbering.
- C. Operation and Maintenance Data: Submit spare parts lists.

1.5 QUALITY ASSURANCE

- A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).
- B. Products shall be FM Approved where listed by Factory Mutual and installation shall be in accordance with FM Global Property Loss Prevention Data Sheets.
- C. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.
- D. In addition to complying with the above codes and regulations, comply with the requirements of the following:
  - 1. NFPA Standard 13.
  - 2. NFPA Standard 24.
  - 3. State Building and Fire Codes.
  - 4. Local Jurisdictional Authorities.

- E. All grooved joint couplings, fittings and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
  - F. All items of similar class shall be the products of the same manufacturer.
  - G. Provide fire sprinkler piping located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with UL 1887.
  - H. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
  - B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Division 1 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Division 1 - Product Requirements: Product storage and handling requirements.
  - B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
  - C. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.
  - D. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.
- 1.9 WARRANTY
- A. Division 1 - Warranties and Bonds: Product warranties and product bonds.
- PART 2 PRODUCTS
- 2.1 BURIED PIPING
- A. Ductile Iron Pipe: ANSI/AWWA C151, cement lined.
    - 1. Fittings: ANSI/AWWA C110, standard thickness.

2. Cast Iron Fittings: ASME B16.1, flanges and flanged fittings.
3. Joints: ANSI/AWWA C111, rubber gasket.

2.2 ABOVE GROUND PIPING

- A. Steel Pipe: ASTM A53; Schedule 40 carbon steel. Schedule 10 pipe shall be allowed for pipe sizes larger than 2" diameter when roll grooved mechanical couplings are used.
- B. Cast Iron Fittings: ANSI/ASME B16.1, flanges and flanged fittings; ANSI/ASME B16.4, screwed fittings.
  1. Malleable Iron Fittings: ANSI/ASME B16.3, screwed Class 300 type. Threads shall conform to ANSI/ASTM A47.
  2. Grooved Mechanical Fittings: ANSI A21.10/AWWA C-110 ductile iron; ASTM A536 Grade 65-45-12 ductile iron; ASTM A234 Grade WPB; or factory fabricated from carbon steel pipe conforming to ASTM A53; with grooves or shoulders designed to accept grooved end couplings. Fittings shall be of the same manufacturer as the adjoining couplings. Grooved Mechanical Couplings: ASTM A536 Grade 65-45-12, ductile iron housing, elastomer gasket with nuts and bolts to secure roll grooved pipe and fittings.
    - a. Manufacturers: Victaulic Model numbers as listed below or approved equal by:
      - 1) Anvil
      - 2) Grinnell Grulok

Fire Protection Service	Temperature Range	Gasket Recommendation
Dry Systems	Ambient	FlushSeal, or EZ Style 009 design Grade EPDM, Type A
Freezer Applications	-40°F to 0°F	FlushSeal, Grade L, Silicone
Water/Wet Systems	Ambient	C-Shape or EZ Style 009

- b. Rigid Type Couplings: Housings cast with offsetting, angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13.
      - 1) 1-1/4" through 4": Factory assembled for direct stab installation without field disassembly. Victaulic Style 009 EZ.
      - 2) 5" through 8": Victaulic FireLock Style 005.
      - 3) 10" and larger: Victaulic Zero-Flex Style 07.
    - c. Flexible Type Couplings: Use in locations where vibration attenuation and stress relief are required, and for seismic considerations in accordance with the manufacturer's instructions. Victaulic Style 75.
- C. Contractor shall provide FLEXHEAD Series 2000, or approved equal as manufactured by Victaulic, Grinnell or Viking, flexible pipe connections for both suspended gypsum ceilings. All flexible piping connections to include a fully welded (non-mechanical fittings), braided, leak-tested, stainless steel sprinkler drop with a minimum internal corrugated hose diameter of 1 inch; and a one-piece multi-port ceiling bracket with removable attachment hub and self-securing integrated snap-on clip-ends, for attachment to

ceiling grid without the need for a screw fastener. All flexible piping systems shall be UL Listed and FM Approved.

### 2.3 ABOVE GROUND PIPING – GALVANIZED

- A. ASTM A795, Type E, Grade A for fire sprinkler applications up to 300 psi working pressure
- B. FM Approved for use in wet systems
- C. Galvanized Steel Pipe: ASTM A795; Schedule 40 seamless galvanized steel. Schedule 10 pipe shall be allowed for pipe sizes larger than 2” diameter when roll grooved mechanical couplings are used. Welded outlet fittings or other “hole cut” type fittings shall not be used. Plain end joint connections shall not be used.
- D. Cast Iron Pipe: AWWA C151.
  - 1. Fittings: AWWA C110, standard thickness.
  - 2. Joints: AWWA C111, rubber gasket.
  - 3. Mechanical Grooved Couplings: Ductile iron housing clamps to engage and lock, "C" shaped composition sealing gasket, steel bolts, nuts, and washers; galvanized for galvanized pipe.

### 2.4 UNIONS AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches (50 mm) and Under:
  - 1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
- B. Dielectric Connections: Union, waterway fitting, or flange with water impervious isolation barrier; Victaulic Style 47 or Watts 3000 Series or approved equal.

### 2.5 PIPE HANGERS AND SUPPORTS

- A. Conform to NFPA 13.
- B. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
- C. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
- D. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- E. Wall Support for Pipe Sizes to 3 inches: Cast iron hook.
- F. Wall Support for Pipe Sizes 4 inches and Over: Welded steel bracket and wrought steel clamp.
- G. Vertical Support: Steel riser clamp.
- H. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Coordinate work of this Section with other affected work.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and foreign material, from inside and outside, before assembly.
- D. Prepare piping connections to equipment with flanges or unions.

#### 3.2 INSTALLATION – GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.
- C. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding.
- D. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.
- E. Pipe Hangers and Supports:
  - 1. Install in accordance with NFPA 13.
  - 2. Install hangers to with minimum 1/2 inch space between finished covering and adjacent work.
  - 3. Place hangers within 12 inches of each horizontal elbow.
  - 4. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
  - 5. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
  - 6. Where installing several pipes in parallel and at same elevation, provide multiple or trapeze hangers.
  - 7. Install sheet lead packing between hanger or support and piping.
  - 8. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

#### 3.3 INSTALLATION – PIPE AND FITTINGS

- A. Pipe/insulation: All wet sprinkler piping must be plumbed on the heated side of the building insulation to prevent freezing. The fire protection contractor must install the wet sprinkler piping such that space is provided around all wet piping for insulation to be installed. The space required for insulation is dictated by the insulation R-value for the specific area as specified by the Architect.

- B. Install piping in accordance with NFPA 13 for sprinkler systems, and NFPA 24 for service mains.
- C. Place piping in concealed spaces above finished ceilings unless noted otherwise.
- D. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- E. Install piping to conserve building space, to not interfere with use of space and other work.
- F. Group piping whenever practical at common elevations.
- G. Install pipe sleeve at piping penetrations through footings, partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.
- H. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- I. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
- J. Pitch piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- K. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding. Refer to Section 09 90 00.
- L. Do not penetrate building structural members unless indicated.
- M. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- N. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.
- O. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.

- P. Provide dielectric fittings whenever joining two dissimilar metals.
  - Q. Provide surge restrainers on all end of branches and arm overs in excess of 12-inches.
- 3.4 SERVICE CONNECTION
- A. Provide new fire service complete with, double check valve assembly and isolation valves with tamper switches.
    - 1. Provide sleeve in wall for service main and support at wall with reinforced concrete bridge. Caulk enlarged sleeve and make watertight with pliable material. Anchor service main inside to concrete wall.
    - 2. Provide 18 gage (1.20 mm) galvanized sheet metal sleeve around service main to 6 inch (150 mm) above floor and 6 feet (1800 mm) minimum below grade. Size for minimum of 2 inches (50 mm) of loose batt insulation stuffing.
    - 3. Seal wall penetration.
- 3.5 TESTING
- A. Piping: The complete system shall be subject to a pressure test, and to such other tests as the authorities having jurisdiction may require. The pressure test shall be a hydrostatic pressure of 200 pounds per square inch for a period of two hours. The above ground piping and attached appurtenances shall show no pressure loss or leaks, refer to NFPA Standard 13 Hydrostatic tests. For buried piping refer to NFPA Standard 24 Testing Underground Systems. Before applying specified test pressure, all air must be expelled from the system. All defects of whatever type shall be repaired or replaced to the satisfaction of the Owner and authorities having jurisdiction and at no additional cost to the Owner. Packing rings, special joint bolts, gaskets, and other material required for the proper installation of the pipe and fittings shall be provided. Testing shall be completed prior to permanent sealing of walls and partitions.
  - B. Leaks in mechanical joints shall be repaired by dismantling the joint, reassembling it, and tightening the bolts in the correct order. Leaks in screw or grooved joint shall be repaired by dismantling the joint and reassembling it. Attempting to repair leaks in joints by over tightening the bolts or fittings shall not be permitted.
  - C. Upon satisfactory completion of all tests, the Contractor shall submit three copies of the Standard Contractors Material and Test Certificate to the Owner.
- 3.6 INTERFACE WITH OTHER PRODUCTS
- A. Inserts:
    - 1. Install inserts for placement in concrete forms.
    - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
    - 3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
    - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.7 CLEANING

- A. Division 1 - Execution and Closeout Requirements: Final cleaning.
- B. Clean entire system after other construction is complete.

END OF SECTION 210500



SECTION 210516 EXPANSION FITTINGS AND LOOPS FOR FIRE SUPPRESSION PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."

1.2 SUMMARY

- A. Section Includes:
  - 1. Flexible pipe connectors.
  - 2. Expansion joints.
  - 3. Expansion compensators.
  - 4. Pipe alignment guides.
  - 5. Swivel joints.
  - 6. Pipe anchors.
- B. Related Sections:
  - 1. 21 05 00 - Common Work Results for Fire Suppression: Product and installation requirements for piping used in fire protection systems.
  - 2. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
  - 3. Section 21 12 00 - Fire-Suppression Standpipes.
  - 4. Section 21 13 13 – Wet-Pipe Sprinkler System.

1.3 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME B31.9 - Building Services Piping.
  - 2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. American Welding Society:
  - 1. AWS D1.1 - Structural Welding Code - Steel.

1.4 DESIGN REQUIREMENTS

- A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

1.5 SUBMITTALS

- A. Division 1 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer.
- C. Product Data:
  - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- D. Design Data: Indicate criteria and show calculations. Submit calculations sealed by a registered professional engineer.
- E. Manufacturer's Installation Instructions: Submit special procedures.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.
- H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.6 CLOSEOUT SUBMITTALS

- A. Division 1 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- C. Operation and Maintenance Data: Submit adjustment instructions.

1.7 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Perform Work in accordance with the Connecticut State Building Code and Connecticut State Fire Safety Code.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed in State of Connecticut.

1.9 PRE-INSTALLATION MEETINGS

- A. Division 1 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Division 1 - Product Requirements: Product storage and handling requirements.
- B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
- C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.11 WARRANTY

- A. Division 1 - Warranties and Bonds: Product warranties and product bonds.
- B. Furnish one year manufacturer warranty for leak free performance of packed expansion joints.

1.12 EXTRA MATERIALS

- A. Division 1 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Supply two 12 ounce containers of packing lubricant and cartridge style grease gun.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
  - 1. Mason.
  - 2. Metraflex.
  - 3. Vibration Eliminator.

- B. Inner Hose: Carbon Steel.
- C. Exterior Sleeve: Double braided stainless steel.
- D. Pressure Rating: 125 psig WSP and 450 degrees F.
- E. Joint: Flanged.
- F. Size: Use pipe-sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.

## 2.2 EXPANSION JOINTS

- A. Manufacturers:
  - 1. Metraflex.
  - 2. Mason.
  - 3. Vibration Elimination.
- B. Pressure Rating: 200 psig WOG and 250 degrees F.
- C. Maximum Compression: 1-3/4 inch.
- D. Maximum Extension: 1/4 inch.
- E. Joint: Flanged.
- F. Size: Use pipe sized units
- G. Application: Steel piping 3 inch and smaller.

## 2.3 ACCESSORIES

- A. Manufacturers:
  - 1. Metraflex.
  - 2. Mason.
  - 3. Vibration Elimination.
- B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.
- C. Swivel Joints: Fabricated steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.9.
- B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Refer to Section 21 05 48. Provide line size flexible connectors.
- C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.
- E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Refer to Section 21 05 00 for pipe hanger installation requirements.
- F. Provide grooved piping systems with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation. Grooved piping systems need not be anchored.
- G. Provide expansion loops as required.

#### 3.2 MANUFACTURER'S FIELD SERVICES

- A. Division 1 - Quality Requirements: Manufacturers' field services.
- B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 210516

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SECTION 210523 GENERAL DUTY VALVES PIPE AND  
FITTINGS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes valves, backflow preventers and accessories for sprinkler standpipe combination sprinkler and standpipe systems.
- B. Related Sections:
  - 1. Division 3 - Concrete Forming and Accessories: Execution requirements for inserts and sleeves specified by this section.
  - 2. Division 9 - Painting and Coating: Execution requirements for piping painting specified by this section.
  - 3. Section 21 04 00 – General Conditions for Fire-Suppression Trades
  - 4. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Piping.
  - 5. Section 21 05 48 – Vibration and Seismic Controls for Fire-Suppression Piping and Equipment.
  - 6. Section 21 13 13 – Wet-Pipe Sprinkler System.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800.
  - 2. ASME B16.3 – Malleable Iron Threaded Fittings, Class 150 and 300.
  - 3. ASME B16.4 - Cast Iron Threaded Fittings, Class 125 and 250.
  - 4. ASME B16.5 - Pipe Flanges and Flanged Fittings
  - 5. ASME B16.9 – Factory-made Wrought Steel Butt Welding Fittings.
  - 6. ASME B16.11 - Forged Steel Fittings - Socket-Welding and Threaded.
  - 7. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
  - 8. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  - 9. ASME B16.25 – Butt Welding Ends.
  - 10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
  - 11. ASME Sec 9 - Welding and Brazing Qualifications.
- B. American Society of Sanitary Engineers:
  - 1. ASSE 1015 – Standard for Double Check Backflow Preventer Assembly
  - 2. ASSE 1048 – Standard for Double Check Detector Assembly Backflow Preventer.
- C. ASTM International:
  - 1. ASTM A47 – Malleable Iron Castings.
  - 2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  - 3. ASTM A135 - Standard Specification for Electric-Resistance-Welded Steel Pipe.

4. ASTM A126 – Standard for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
  5. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
  6. ASTM A536 – Standard for Ductile Iron Casting.
  7. ASTM A795/A795M - Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use.
  8. ASTM B32 - Standard Specification for Solder Metal.
  9. ASTM B75 - Standard Specification for Seamless Copper Tube.
  10. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
  11. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
- D. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
  2. AWS D1.1 - Structural Welding Code - Steel.
  3. AWS D10.9 - Specifications for Qualification of Welding Procedures and Welders for Piping and Tubing.
- E. American Water Works Association:
1. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
  2. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  3. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
  4. AWWA C510 – Standard for Double Check Valve Backflow Prevention Assembly.
  5. AWWA C606 – Standard for Grooved and Shouldered Joints.
- F. National Fire Protection Association:
1. NFPA 13 - Installation of Sprinkler Systems.
  2. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.
- G. Underwriter Laboratories, Inc.:
1. UL 1887 - Fire Tests of Plastic Sprinkler Pipe for Visible Flame and Smoke Characteristics.
  2. UL - Fire Resistance Directory.
- H. Factory Mutual:
1. FM - Factory Mutual Approval Guide.



1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
- C. Product Data: Submit manufacturer's catalogue information. Provide data on valves, and fittings, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- D. Manufacturer's Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and tag numbering.
- C. Operation and Maintenance Data: Submit spare parts lists.

1.5 QUALITY ASSURANCE

- A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).
- B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.
- C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
  - 1. NFPA Standard 13.
  - 2. NFPA Standard 24.
  - 3. State Building and Fire Codes.
  - 4. Local Jurisdictional Authorities.

- D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
  - E. Valves: Bear UL and/or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
  - F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.
  - G. Provide fire sprinkler piping located in plenums with peak optical density not greater than 0.5, average optical density not greater than 0.15, and flame spread not greater than 5 feet (1.5 m) when tested in accordance with UL 1887.
  - H. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
  - B. Installer: Company specializing in performing Work of this section with minimum five years documented experience.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Division 1 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Division 1 - Product Requirements: Product storage and handling requirements.
  - B. Deliver and store valves in shipping containers, with labeling in place.
  - C. Furnish cast iron and steel valves with temporary protective coating.
  - D. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
  - E. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.
  - F. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.

- G. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

## 1.9 WARRANTY

- A. Division 1 - Warranties and Bonds: Product warranties and product bonds.

## 1.10 EXTRA MATERIALS

- A. Division 1 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of valve stem packing for each size and type of valve installed.

## PART 2 PRODUCTS

### 2.1 VALVES

- A. Manufacturers:
  1. Kennedy Valve Mfg. Co.
  2. Victaulic.
  3. Anvil.
  4. Grinnell.
  5. Stockham.
  6. Nibco.
  7. Watts.
  8. Hammond.
  9. Milwaukee.
- B. Gate Valves:
  1. Up to and including 2 inches: Bronze body and trim, 175 lb, cold water non-shock working pressure, rising stem, hand wheel, solid wedge or disc, threaded ends.
  2. Over 2 inches: Iron body, bronze trim, 175 lb, cold water non-shock working pressure, rising stem pre-grooved for mounting tamper switch, hand wheel, outside screw and yoke, solid taper bronze or cast iron wedge, grooved or flanged ends.
  3. Over 4 inches: Iron body, bronze trim, 175 pound cold water, non-shock working pressure. Valve shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet with body and bonnet conforming to ASTM A126 Class B; replaceable bronze wedge facing rings; grooved or flanged ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet and bronze bonnet bushing. Valve shall be capable of being repacked under pressure, with valve wide open.

- C. Globe Valves:
  - 1. Up to and including 2 inches: Class 125, Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity, packable under pressure.
  - 2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, grooved or flanged ends, renewable seat and disc.
  
- D. Angle Valves:
  - 1. Up to and including 2 inches: Class 125, Bronze body, bronze trim, rising stem and hand wheel, inside screw, renewable rubber disc, threaded ends, with back seating capacity, packable under pressure.
  - 2. Over 2 inches: Iron body, bronze trim, rising stem, hand wheel, OS&Y, plug-type disc, grooved or flanged ends, renewable seat and disc.
  
- E. Ball Valves:
  - 1. Up to and including 2 inches: Bronze two piece body, standard port, chrome plated brass ball, 316 stainless steel stem, teflon seats brass stem nut, die-cast brass gear box with supervisory switches, threaded ends.
  - 2. Over 2 inches: Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, grooved or flanged ends, lever handle, .
  
- F. Butterfly Valves:
  - 1. Ductile iron body, ductile iron disc with EPDM disc coating and integrally cast stem, grooved or flanged ends.
  - 2. Cast bronze body, ductile iron disc with EPDM disc coating and integrally cast stem, copper-tubing dimensioned grooved ends.
  - 3. Cast iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck with 316 stainless steel stem, MSS-SP-67, 200 psi.
  - 4. Disc: EPDM coated ductile iron or Aluminum bronze.
  - 5. Operator: Notched plate lever handle. handwheel gear drive and weatherproof actuator with supervisory switches.
  
- G. Check Valves:
  - 1. Up to and including 2 inches: Class 125, Bronze swing disc, screwed ends.
  - 2. Horizontal Swing Over 2 inches:
    - a. 300 psi CWP, ductile iron body and coupled cap conforming to ASTM A536, Grade 65-45-12; horizontal swing, with stainless steel disc, elastomer seat, and grooved or flanged ends.
    - b. Class 175, cast iron body and bolted cap conforming to ASTM A126, Class B; horizontal swing, with a bronze disc or cast iron disc with bronze disc ring, and flanged ends.
    - c. Valve shall be capable of being refitted while the valve remains in line.
  - 3. Spring Actuated Over 2 inches:
    - a. 300 psi CWP, ductile iron body conforming to ASTM A536, Grade 65-45-12; vertical or horizontal check; with stainless steel spring and shaft.
      - 1) 2-1/2 (65 mm) and 3 inches (75 mm): Aluminum bronze disc with disc mounted elastomer seal and PPS (Polyphenylene Sulfide) coated seat.

- 2) 4 inches (100 mm) and Larger: Elastomer coated ductile iron disc with welded-in nickel seat.

H. Drain Valves:

1. Compression Stop: Bronze with hose thread nipple and cap.
2. Ball Valve: Brass with cap and chain, 3/4 inch hose thread.

- I. All valves shall be either UL listed or FM approved for use on fire protection systems.

2.2 BACKFLOW PREVENTERS

- A. Double Check Detector Check Valve Assemblies: ANSI/ASSE 1048, AWWA C510; bronze body; two independently operating, spring loaded check valves; metered bypass; assembled with two butterfly valves, strainer, test cocks. Watts as scheduled or approved equal as manufactured by Viking, Stockham or Milwaukee.

2.3 UNIONS AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches (50 mm) and Under:
1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
  2. Copper Pipe: Bronze, soldered joints.
- B. Dielectric Connections: Union, waterway fitting, or flange with water impervious isolation barrier.

PART 3 EXECUTION

3.1 PREPARATION

- A. Coordinate work of this Section with other affected work.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and foreign material, from inside and outside, before assembly.
- D. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION – GENERAL

- A. Install in accordance with manufacturer's instructions.
- B. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.
- C. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding.
- D. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.

3.3 INSTALLATION – PIPE AND FITTINGS

- A. Pipe/insulation: All wet sprinkler piping must be plumbed on the heated side of the building insulation to prevent freezing. The fire protection contractor must install the wet sprinkler piping such that space is provided around all wet piping for insulation to be installed. The space required for insulation is dictated by the insulation R-value for the specific area as specified by the Architect.
- B. Install piping in accordance with NFPA 13 for sprinkler systems, and NFPA 24 for service mains.
- C. Place piping in concealed spaces above finished ceilings unless noted otherwise.
- D. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- E. Install piping to conserve building space, to not interfere with use of space and other work.
- F. Group piping whenever practical at common elevations.
- G. Install pipe sleeve at piping penetrations through footings partitions, walls, and floors. Seal pipe and sleeve penetrations to maintain fire resistance equivalent to fire separation.
- H. Grooved joint couplings and fittings shall be installed in accordance with the manufacturer's written installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be verified as suitable for the intended service prior to installation. Gaskets shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and installation of grooved joint products. The manufacturer's representative shall periodically visit the jobsite and review installation. Contractor shall remove and replace any joints deemed improperly installed.
- I. Pitch piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level.
- J. Prepare pipe, fittings, supports, and accessories for finish painting. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
- K. Do not penetrate building structural members unless indicated.
- L. Provide sleeves when penetrating footings, floors and walls. Seal pipe and sleeve penetrations to achieve fire resistance equivalent to fire separation required.

- M. Where more than one piping system material is specified, install compatible system components and joints. Install flanges, union, and couplings at locations requiring servicing.
- N. Die cut threaded joints with full cut standard taper pipe threads with red lead and linseed oil or other non-toxic joint compound applied to male threads only.
- O. Provide dielectric fittings whenever joining two dissimilar metals.
- P. Provide surge restrainers on all end of branches and arm overs in excess of 12-inches.

#### 3.4 INSTALLATION – VALVES

- A. Install drain valves at main shut-off valves, low points of piping and apparatus.
- B. All valves shall be accessible for operation and servicing. Provide access panels where required.
- C. Install valves with stems upright or horizontal, not inverted. Remove protective coatings prior to installation.
- D. Install gate butterfly valves for shut-off or isolating service.
- E. Install buried shut-off valves in valve box. Provide post indicator valve.

#### 3.5 TESTING

- A. Piping: The complete system shall be subject to a pressure test, and to such other tests as the authorities having jurisdiction may require. The pressure test shall be a hydrostatic pressure of 200 pounds per square inch for a period of two hours. The above ground piping and attached appurtenances shall show no pressure loss or leaks, refer to NFPA Standard 13 Hydrostatic tests. For buried piping refer to NFPA Standard 24 Testing Underground Systems. Before applying specified test pressure, all air must be expelled from the system. All defects of whatever type shall be repaired or replaced to the satisfaction of the Owner and authorities having jurisdiction and at no additional cost to the Owner. Packing rings, special joint bolts, gaskets, and other material required for the proper installation of the pipe and fittings shall be provided. Testing shall be completed prior to permanent sealing of walls and partitions.
- B. Leaks in mechanical joints shall be repaired by dismantling the joint, reassembling it, and tightening the bolts in the correct order. Leaks in screw or grooved joint shall be repaired by dismantling the joint and reassembling it. Attempting to repair leaks in joints by over tightening the bolts or fittings shall not be permitted.
- C. Upon satisfactory completion of all tests, the Contractor shall submit three copies of the Standard Contractors Material and Test Certificate to the Owner.

3.6 INTERFACE WITH OTHER PRODUCTS

- A. Inserts:
  - 1. Install inserts for placement in concrete forms.
  - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Install hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
  - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.7 CLEANING

- A. Division 1 - Execution and Closeout Requirements: Final cleaning.
- B. Clean entire system after other construction is complete.

END OF SECTION 210523



SECTION 210548 VIBRATION AND SEISMIC CONTROLS FOR  
FIRE SUPPRESSION PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Seismic restraints for fire protection piping and equipment.
  - 2. Certification of seismic restraint designs and installation supervision.
  - 3. Certification of seismic attachment of housekeeping pads.
  
- B. Related Sections:
  - 1. Section 21 05 00 – Common work results for Fire-Suppression.
  - 2. Section 21 05 16 - Expansion Fittings and Loops for Fire-Suppression Piping: Product requirements for anchors and piping expansion compensation.
  - 3. Section 21 04 00 – General Conditions for Fire-Suppression Trades.

1.2 REFERENCES

- A. National Fire Protection Association
  - 1. NFPA 13 – Standard for the Installation of Sprinkler Systems

1.3 PERFORMANCE REQUIREMENTS

- A. Provide seismic restraints in accordance with the requirements of NFPA 13.
  
- B. Provide seismic restraints even though project is exempt per building code requirements (Seismic Design Category B).

1.4 SUBMITTALS

- A. Division 01 - Submittal Procedures: Submittal procedures.
  
- B. Shop Drawings:
  - 1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
  - 2. Provide all details of suspension and support for ceiling suspended equipment.
  - 3. Where walls, floors, slabs or supplementary steel work are used for seismic restraint locations, details of acceptable attachment methods for ducts, conduit and pipe must be included and approved before the condition is accepted for installation. Restraint manufacturers' submittals must include spacing, static loads and seismic loads at all attachment and support points.
  - 4. Provide specific details of seismic restraints and anchors; include number, size and locations for each piece of equipment.

- C. Product Data:
  - 1. Catalog cuts or data sheets on specific restraints detailing compliance with the specification.
  - 2. Detailed schedules of flexible and rigidly mounted equipment, showing seismic restraints by referencing numbered descriptive drawings.
  
- D. Seismic Certification and Analysis:
  - 1. Seismic restraint calculations must be provided for all connections of equipment to the structure. Calculations must be stamped by a registered professional engineer with at least five years of seismic design experience, licensed in the state of the job location.
  - 2. Calculations (including the combining of tensile and shear loadings) to support seismic restraint designs must be stamped by a registered professional engineer with at least five years of seismic design experience and licensed in the state of the job location. Testing and calculations must include both shear and tensile loads as well as one test or analysis at 45° to the weakest mode.
  - 3. Analysis must indicate calculated dead loads, static seismic loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length.
  
- E. Manufacturer's Responsibilities:
  - 1. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
  - 2. Provide written certification that isolators meet or exceed specified requirements.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Division 01 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of seismic restraints.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- C. Design application of seismic restraints under direct supervision of Professional Engineer experienced in design of this Work and licensed in the State where the Project is located.

#### 1.7 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.8 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Requirements for warranties.

PART 2 PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. All seismic restraints described in this section shall be the product of a single manufacturer
- B. Provide products manufactured by one of the following:
1. Mason Industries
  2. Vibration Eliminator
  3. Vibro-Acoustics Ltd.
  4. Metraflex Company

2.2 SEISMIC CABLE RESTRAINTS

- A. Seismic Cable Restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
- B. Cables must be prestretched to achieve a certified minimum modulus of elasticity.
- C. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
- D. Cables must not be allowed to bend across sharp edges.
- E. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod nut and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.

2.3 SEISMIC SOLID BRACES

- A. Seismic solid braces shall consist of steel angles or channels to resist seismic loads with a minimum safety factor of 2 and arranged to provide all directional restraint.
- B. Seismic solid brace end connectors shall be steel assemblies that swivel to the final installation angle and utilize two through bolts to provide proper attachment.
- C. Seismic solid brace assembly shall have anchorage preapproval "OPA" number from OSHPD in the state of California verifying the maximum certified load ratings.
- D. Solid seismic brace assemblies shall be type SSB, SSBS or SSRF as manufactured by Mason Industries, Inc.

#### 2.4 SEISMIC ROD CLAMPS

- A. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable.
- B. Rod clamp assemblies shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California.
- C. Rod clamp assemblies shall be type SRC or UC as manufactured by Mason Industries, Inc.

#### 2.5 CLEVIS CROSS BRACE

- A. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt.
- B. Clevis cross braces shall have an Anchorage Preapproval "OPA" Number from OSHPD in the State of California.
- C. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.

#### 2.6 STUD WEDGE ANCHORS

- A. Stud wedge anchors shall be manufactured from full diameter wire, not from undersized wire that is "rolled up" to create the thread.
- B. The stud anchor shall also have a safety shoulder which fully supports the wedge ring under load.
- C. The stud anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying its allowable loads.
- D. Drill-in stud wedge anchors shall be type SAS as manufactured by Mason Industries, Inc.

#### 2.7 FEMALE WEDGE ANCHORS

- A. Female wedge anchors are preferred in floor locations so isolators or equipment can be slid into place after the anchors are installed.
- B. Anchors shall be manufactured from full diameter wire, and shall have a safety shoulder to fully support the wedge ring under load.
- C. Female wedge anchors shall have an evaluation report number from the I.C.B.O Evaluation Service, Inc. verifying to its allowable loads.
- D. Drill-in female wedge anchors shall be type SAB as manufactured by Mason Industries, Inc.

2.8 STAINLESS STEEL HOSE

- A. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" (75mm) and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

Flanged

3" x 14" (75 x 350mm)	6" x 20" (150 x 500mm)	12" x 28" (300 x 700mm)
4" x 15" (100 x 375mm)	8" x 22" (200 x 550mm)	14" x 30" (350 x 750mm)
5" x 19" (125 x 475mm)	10" x 26" (250 x 650mm)	16" x 32" (400 x 800mm)

Male Nipples

1/2" x 9" (12 x 225mm)	1 1/4" x 12" (32 x 300mm)	2" x 14" (50 x 350mm)
3/4" x 10" (19 x 250mm)	1 1/2" x 13" (38 x 325mm)	2 1/2" x 18" (64 x 450mm)
1" x 11" (25 x 275mm)		

- B. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.
- C. Hoses shall be type BSS as manufactured by Mason Industries, Inc.

2.9 HOUSEKEEPING PAD ANCHORS

- A. Housekeeping pad anchors shall consist of a ductile iron casting that is tapered and hexagonal, smaller at its base than at its top.
- B. The upper portion shall have holes for rebar to pass through.
- C. The anchor shall be continuously threaded from top to bottom for the attachment of soleplates.
- D. Housekeeping pad anchors shall be attached to the structural slab using a stud wedge anchor.
- E. Housekeeping pad anchors shall be type HPA and stud wedge anchor shall be type SAS both as manufactured by Mason Industries, Inc.

2.10 FLEXIBLE EXPANSION LOOP

- A. All sprinkler pipe passing through or crossing building seismic joints, shall contain a flexible expansion loop, designed for seismic movement.
- B. Flexible loops shall impart no thrust loads to building structure.
- C. Loops shall be located at, or near, the building seismic joint. Seismic bracing shall not pass through building seismic joint and shall not connect or tie together different sides or parts of building structure. Refer to architectural drawings for locations of building seismic joints.
- D. Flexible loops shall be capable of movement in the X, Y, and Z planes.

- E. All flexible loop connections to sprinkler piping shall be installed, inspected, and tested in accordance with current NFPA-13 standards.
- F. Flexible loops shall consist of two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return. Loops shall include a factory supplied, center support nut located at the bottom of the 180 degree return, and a drain/air release plug. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings.
- G. Alternatively, the flexible loop shall consist of two flexible sections of hose and braid, two 45 degree elbows, and 90 degree return. Loops shall include a factory supplied, center support nut located at the bottom of the 90 degree return, and a drain/air release plug. Materials of construction and end fitting type shall be consistent with pipe material and equipment/pipe connection fittings
- H. Flexible expansion/seismic loops to be Metraloop Fireloop or Metraloop Firevoop as manufactured by The Metraflex Company, Chicago, IL.
- I. Provide seismic breakaway hangers where recommended by the flexible expansion loop manufacturer. Seismic breakaway hanger shall be by the same manufacturer as the flexible expansion loop.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Division 01 - Administrative Requirements: Coordination and project conditions.
- B. Verify equipment and piping is installed before work in this section is started.

### 3.2 INSTALLATION

- A. All seismic restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- B. Installation of seismic restraints must not cause any change of position of equipment or piping resulting in stresses or misalignment.
- C. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- D. Correct, at no additional cost, all installations which are deemed defective in workmanship and materials at the contractor's expense.

- E. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
  - 1. Flanges of structural beams.
  - 2. Upper truss cords in bar joist construction.
  - 3. Cast in place inserts or wedge type drill-in concrete anchors.
- F. Seismic cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- G. Seismic cable assemblies are installed taut on non-isolated systems. Seismic solid braces may be used in place of cables on rigidly attached systems only.
- H. At locations where seismic cable restraints or seismic solid braces are located, the support rods must be braced when necessary to accept compressive loads.
- I. At all locations where seismic cable restraints or seismic solid braces are attached to pipe clevis's, the clevis cross bolt must be reinforced with a preformed heavy gauge channel cross brace.
- J. Drill-in concrete anchors for ceiling and wall installation shall be stud wedge anchors or female wedge anchors for floor mounted equipment.
- K. All fire protection piping shall be braced in accordance with NFPA 13.

END OF SECTION 210548

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## SECTION 211313 WET PIPE SPRINKLER SYSTEMS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes wet-pipe sprinkler system, system design, installation, and certification.
- B. Related Sections:
  - 1. Section 21 05 00 - Common Work Results for Fire Suppression: Product and execution requirements for pipe, fittings, valves, hangers, supports, identification and painting for placement by this section.
  - 2. Section 21 05 16 – Expansion Fittings and Loops for Fire-Suppression Equipment.
  - 3. Section 21 05 48 - Vibration and Seismic Controls for Fire-Suppression Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
  - 4. Section 21 04 00 – General Conditions for Fire Suppression Trades
  - 5. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to equipment specified by this section.

#### 1.2 REFERENCES

- A. National Fire Protection Association:
  - 1. NFPA 13 - Installation of Sprinkler Systems.
  - 2. NFPA 24 - Installation of Private Fire Service Mains and Their Appurtenances.
- B. Factory Mutual:
  - 1. FM - Factory Mutual Approval Guide.
- C. Underwriters Laboratory:
  - 1. UL - Fire Resistance Directory.

#### 1.3 SYSTEM DESCRIPTION

- A. Provide a wet pipe system hydraulically designed in accordance with NFPA 13 and all requirements of the local Authority Having Jurisdiction.
- B. System to provide coverage for entire building.
- C. Provide system to NFPA Standard occupancy requirements as noted on the drawings.
- D. Hydraulic data and water supply information shall be as noted on the drawings.
- E. Interface system with building fire alarm system.
- F. The sprinkler locations and piping arrangements indicated on the contract documents are diagrammatic. It is the responsibility of the contractor to fully coordinate sprinkler and piping locations with all other trades.

- G. Sprinkler locations indicated on the Contract Documents indicate sprinkler coverage utilizing standard coverage sprinklers maximum 225 square feet per sprinkler for light hazard and 130 square feet per sprinkler for ordinary hazard. Extended coverage sprinklers shall not be installed in any locations unless specifically indicated on the Contract Document drawings.
- H. All sprinklers installed in a light hazard classification occupancy shall be a listed quick response type.
- I. Provide fire department connections as indicated on Drawings.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Where the terms “authorities having jurisdiction” is used, within this Specification, it is intended to include the Insurance Underwriter and all regulatory agencies having vested interest in this project.
- C. Shop Drawings:
  - 1. Provide fire protections shop drawings drawn to a minimum scale of ¼”=1’-0”.
  - Indicate pipe materials used, joining methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.
  - 2. Provide hydraulic calculations, detailed pipe layout, hangers and supports, components and accessories. Indicate system controls.
  - 3. All sprinkler drawings and calculations shall bear the seal of a Professional Engineer licensed in the State of Connecticut. Seal and signature shall not be copied and shall be provided as an original drawing and each calculation.
  - 4. Sprinklers shall be as shown on drawings and submittals and shall be specifically identified with the applicable style or series designation as published in the appropriate agency listing or approval. Trade names or other abbreviated designations are not permitted.
- D. Product Data: Provide data on sprinklers, valves, and specialties, including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- E. After successful review by the Engineer, submit sprinkler layout shop drawings, product data, hydraulic calculations to authority having jurisdiction, Fire Marshall, and Owner's insurance underwriter for approval. Submit proof of approval to Architect/Engineer.
- F. Manufacturer’s Certificate: Certify that system has been tested and meets or exceeds specified requirements and all code requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of sprinklers and deviations of piping from drawings. Indicate drain and test locations.
- C. Operation and Maintenance Data: Submit components of system, servicing requirements, record drawings, inspection data, replacement part numbers and availability, and location and numbers of service depot.

1.6 QUALITY ASSURANCE

- A. Workmanship and Qualifications: All materials and equipment shall be installed in accordance with NFPA and all applicable local codes and ordinances. The Sprinkler Contractor shall be state licensed to install sprinkler systems. The Sprinkler Contractor shall make sure that all work and materials conform to the requirements set forth by this Specification. Fire protection equipment shall be installed to conform to NFPA as applicable, and devices used shall be listed and approved by Underwriters laboratories (UL) and/or Factory Mutual (FM).
- B. Codes and Standards: All work shall be equal or superior to that required by codes, regulations, ordinances, and laws imposed by the jurisdictional authorities, including those of the State of Connecticut, State Fire Marshall, local ordinances and OSHA. Nothing in the Specifications permit violations of such directives, and where conflict occurs, the directive shall govern, except where superior work is specified or indicated.
- C. In addition to complying with the above codes and regulations, comply with the requirements of the following:
  - 1. NFPA Standard 13.
  - 2. NFPA Standard 24.
  - 3. State Building and Fire Codes.
  - 4. Local Jurisdictional Authorities.
- D. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.
- E. Valves: Bear UL and/or FM label or marking. Provide manufacturer's name and pressure rating marked on valve body.
- F. All items of similar class shall be the products of the same manufacturer. All valves, accessory items, etc., shall be from the same source.
- G. Maintain one copy of each applicable NFPA standard on site.
- H. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

- I. Installer: Company specializing in performing work of this Section with minimum five years experience.
- J. Design sprinkler system under direct supervision of a Professional Engineer experienced in design of this Work and licensed in the State where the project is located.

#### 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

#### 1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Deliver and store products in shipping containers, with labeling in place.
- C. All equipment, valves, gages and etc., shall be covered and protected during the execution of the work. All equipment and piping shall be protected from freezing. Labeling to remain in place.
- D. All unloading, hauling, and handling of materials shall be the responsibility of the Sprinkler Contractor.
- E. The Sprinkler Contractor can obtain information on available storage space on site from the Owner when making examination of the site.

#### 1.10 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.

#### 1.11 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish extra sprinklers under provisions of NFPA 13.
- C. Furnish suitable wrenches for each sprinkler type.
- D. Provide metal storage cabinet adjacent to the sprinkler service riser for extra sprinklers.

## PART 2 PRODUCTS

### 2.1 SPRINKLERS

- A. Manufacturers:
  - 1. Viking.
  - 2. Tyco.
  - 3. Victaulic.
  - 4. Grinnell Corp.
  - 5. Reliable Sprinkler Corp.
- B. All sprinklers shall be adjustable, glass bulb, automatic sprinklers with ½ inch orifice and 5.6 K-factor unless noted otherwise. Type of sprinkler head shall be as indicated on the plans and in accordance with the following.
- C. Sprinkler bodies shall be die-cast brass, with hex shaped wrench boss integrally cast into the sprinkler body to reduce the risk of damage during installation.
- D. Unless noted otherwise, ordinary temperature rated sprinkler heads shall be used throughout the building.
- E. Where sprinklers will be installed in close proximity to heat sources and special locations, as identified in NFPA 13, temperature ratings shall be in accordance with the requirements of NFPA 13
- F. Where plans call for extended coverage sprinkler heads coordinate coverage requirements with required pressure and K-factor.
- G. Spare Sprinklers: The Sprinkler Contractor shall furnish spare automatic sprinklers in accordance with the requirements of NFPA for stock of extra sprinklers. The sprinklers shall be packed in a suitable container and shall be representative of, and in proportion to, the number of each type and temperature rating of the sprinklers installed. The Sprinkler Contractor shall furnish no less than two special sprinkler wrenches, or at least one wrench for each container or sprinkler box, whichever is greater.
- H. In areas where sprinkler heads are subject to physical damage, provide sprinkler guard assembly over head, finish to match sprinkler finish. This shall include but not limited to the following locations.
  - 1. Heads in elevator shafts.
  - 2. Heads under lower rakes of stairways.
  - 3. Heads in electrical rooms, boiler rooms and other mechanical rooms.
  - 4. Heads installed 7'-0" or less above finished floors.
  - 5. Heads in gymnasium/fitness center areas.

I. Sprinklers shall be in accordance with the following table:

Sprinkler Type	Sprinkler Finish	Manufacturer/Model Number
Pendant Type Sprinklers	Chrome plated finish with chrome plated surface escutcheon	Victaulic Model V2707.
Upright Type Sprinklers	Brass finish.	Victaulic Model V2703.
Semi-recessed Pendant Type Sprinklers	Chrome plated finish with chrome plated, adjustable semi-recessed escutcheon.	Victaulic Model V2707.
Concealed Type Sprinklers	Brass finish with factory painted white cover plate.	Victaulic Model V3801.
Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V2709.
Quick-response Pendant and Upright Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V2708 and V2704.
Quick-response Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V2710.
Quick-response Concealed Type Sprinklers	Brass finish with factory painted white cover plate.	Victaulic Model V3802.
Dry Pendant Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3607.
Dry Horizontal Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3609.
Quick-response Dry Pendant Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3608.
Quick-response Dry Horizontal Sidewall Type Sprinklers	Chrome plated finish with chrome plated, adjustable, semi-recessed escutcheon.	Victaulic Model V3610.

## 2.2 ALARM CHECK VALVES

- A. Manufacturers:
1. Viking.
  2. Tyco.
  3. Victaulic.
  4. Grinnell Corp.

5. Reliable Sprinkler Corp.
- B. Wet Pipe Alarm Valve:
1. Check type valve with Nitrile seat o-ring aluminum bronze clapper with EPDM seal to automatically actuate electrically and hydraulically operated alarms, with pressure retard chamber and variable pressure trim. Valve internal components shall be replaceable without removing valve from the installed position. Valve shall be Series 751 as manufactured by Victaulic Co or approved equal.
  2. Provide retard chamber as part of wet alarm valve trim to allow for pressure fluctuations. Retard chamber shall be Victaulic Series 752 or approved equal by manufacturers listed above. Provide all other trim as recommended by the manufacturer.
  3. Alarm check valve assembly shall allow discharge of one or more sprinklers to activate electric and hydraulic alarms.

### 2.3 PIPING SPECIALTIES

- A. Manufacturers:
1. Potter.
  2. Potter-Roemer.
  3. System Sensor.
  4. Victaulic.
  5. Viking.
- B. Electric Alarm: Electrically operated red enameled gong with pressure alarm switch, 120 volt with weatherproof deep set back box.
- C. Water Flow Switch: Vane type switch for mounting horizontal or vertical, with two form C contacts; rated 10 amp at 120 volt.
- D. Valve Tamper Supervisory Switch: Two form C contacts; rated 10 amp at 120 volt. UL listed and FM approved. Up to 2" – Potter Model PCVS-1. Over 2" switch shall be Potter Model OSYSU-2.
- E. Pressure Switch: ½ inch male pressure connection to alarm valve riser and actuated by any flow of water in excess of one sprinkler. Maximum pressure rating 175 psi, weather-proof with tamper resistant screws, rated 10 amps at 120 volt.
- F. Pressure Gage: Rated for 300 psi use, 3-1/2" in diameter.

### 2.4 FIRE DEPARTMENT CONNECTION

- A. *Fire department connection shall be siamese type, polished brass, single clapper, flush mounted type connection. Provide with polished brass identification plate.*
- B. *Clapper design shall allow for one or both inlets to be pressurized during operation.*
- C. *Provide polished chrome caps and chains for protection of the 2-1/2" inlets.*

- D. *The fire department connection shall be constructed of cast brass with brass clapper, brass swivel couplings and a brass hinge pin. The words "AUTO SPKR" and "F.D. Conn" shall be cast in raised letters on the body.*
- E. *Fire department connection threads shall match the local fire departments standard.*
- F. *Drain: 3/4 inch automatic drip, install at low point after check valve, pipe to building exterior.*
- G. *Label: "Fire Department Connection".*

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Coordinate work of this Section with other affected work.
- B. Prepare piping connections to equipment with grooved joint couplings, flanges, or unions.

#### 3.2 INSTALLATION

- A. Install equipment in accordance with manufacturers instructions.
- B. Install fire protection systems in accordance with NFPA 13 for sprinkler systems, and NFPA 24 for service mains.
- C. Impairments to the existing water supplies shall be minimized. All work shall be complete before making the final connections to the existing water supplies. The Contractor shall notify the owner's representative before impairing any fire protection equipment.
- D. The Contractor shall maintain a clean and orderly site during the installation of the sprinkler system. Materials shall not be stored in the halls or other public areas.
- E. Cutting, welding and other hot work shall not be permitted without permission from the building owner. Contractor shall provide a fire watch for one hour after all welding
- F. The required tests shall be witnessed by the Fire Marshall, authority having jurisdiction, Owner's insurance underwriter and Architect/Engineer.
- G. Provide Double check valve assembly at with detector check assembly sprinkler system water source connection. The backflow device shall be installed at a minimum height to allow installation of the air gap fitting, but shall not be installed at more than 5'0" above finished floor for maintenance.
- H. Locate fire department connection with sufficient clearance from walls, obstructions, etc., to allow full swing of fire department wrench handle. Coordinate the exact location of the fire department connection with the local fire officials. Installation shall conform to the local fire officials requirements.



- I. Installation of Alarm Valves: Install a drain line from the drain connection to the nearest floor drain. Install a test line from the test connection to the exterior of the building. Provide a splash block. Provide gate valves at each line.
- J. Minimum alarm valve riser shall be 4-inch.
- K. Locate electric bell on building wall as indicated
- L. Center heads in two directions in ceiling tile and provide piping offsets as required.
- M. Provide sprinklers below ductwork, cable, raceway and similar obstructions that are 48" in width or greater.
- N. Sprinkler Bulb protector must remain in place until the sprinkler is completely installed.
- O. Remove the bulb protector by hand after installation and before the system is placed in service. (Do not use any tools to remove the bulb protector.)
- P. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.
- Q. Coordinate flow switches, tamper switches, and all other sprinkler devices with the fire alarm system.
- R. Provide wire guards on sprinklers as indicated on drawings.
- S. Place pipe runs to minimize obstruction to other work.
- T. Install piping in concealed spaces above finished ceilings.
- U. Hydrostatically test entire system in accordance with the requirements of NFPA 13.
- V. Require test be witnessed by Fire Marshall. Authority having jurisdiction. Owner's insurance underwriter. Architect/Engineer.
- W. Provide sprinklers and piping as required by NFPA 13 to protect ceiling pockets and similar features.

### 3.3 INTERFACE WITH OTHER PRODUCTS

- A. Verify signal devices are installed and connected to fire alarm system.

### 3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Flush entire piping system of foreign matter.

3.5 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
- B. Apply masking tape or paper cover to protect concealed sprinklers, cover plates, and sprinkler escutcheons not receiving field paint finish. Remove after painting. Replace painted sprinklers with new.

3.6 IDENTIFICATION

- A. Provide and apply signs to control, drain, test and alarm valves to identify their purpose and function. Provide and permanently attach hydraulic calculations data nameplate at the controlling valve for the sprinkler system. Provide lettering size and style from NFPA's suggested styles.

3.7 TESTING

- A. Section 21 05 00 - Common Work Results for Fire Suppression.

END OF SECTION 211313

SECTION 220400 GENERAL CONDITIONS FOR PLUMBING TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to certain sections of Division 26, "Electrical," and this section applies to all sections of Division 22, "Plumbing" of this project specification unless specified otherwise in the individual sections.
- C. The Drawings of other trades (Architectural, Food Service, Structural, Landscape, Civil, Mechanical, Fire Protection and Electrical) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.
- D. Products shall be FM Approved where listed by Factory Mutual and installation shall be in accordance with FM Global Property Loss Prevention Data Sheets.
- E. Section 01 91 13 – General Commissioning Requirements and related specification sections apply.
- F. Section 017419 - Construction and Demolition Waste Management and Disposal.
- G. Section 018113 - Sustainable Design Requirements.
- H. Section 018119 - Construction Indoor Air Quality Requirements.

1.2 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification
- B. LEED v4 Submittals: For all interior, wet-applied adhesives, sealants, paints and coatings related to the work of this Section, submit product and material documentation as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

1.3 DESCRIPTION

- A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.

1.4 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.
- C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.
- D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

1.5 DEFINITIONS

- A. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.
- B. "Approved equal" mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.
- C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.

- D. “Finished” refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.
- E. “Furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.
- F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.
- G. “Install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.
- H. "Lead Free" shall mean not more than .25% in the wetted surface area.
- I. “Product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
- J. “Provide” shall mean furnish (or supply) and install as necessary.
- K. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- L. Remove: The term “remove” means “to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”
- M. Special Warranties: The term “Special Warranties” are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.
- N. Standard Product Warranties: The term “Standard Product Warranties” are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- O. “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.
- P. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."
- Q. “Wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.

1.6 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)
- B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.
- C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

1.7 CODES AND STANDARDS

- A. Reference Standard Compliance
  - 1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
  - 2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- B. The Following Codes and Standards listed below apply to all plumbing work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
  - Connecticut State Building Code Including all Supplements
  - Connecticut State Fire Safety Code Including all Supplements
  - Connecticut Building Standards Guidelines – Compliance for High Performance Buildings
  - The International Building Code
  - The International Mechanical Code
  - The International Plumbing Code
  - The International Energy Conservation Code

NFPA 70, the National Electrical Code  
NFPA 101, the Life Safety Code  
ASHRAE 90.1 and International Energy Conservation Code

C. The following Standards shall be used where referenced by the following abbreviations:

ACGIH	American Conference of Governmental Industrial Hygienists
AGA	American Gas Association
AIA	American Institute of Architects
ANSI	American National Standards Institute
API	American Petroleum Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASPE	American Society of Plumbing Engineers
ASSE	American Society of Sanitary Engineers
ASTM	American Society of Testing and Materials
AWS	American Welding Society
AWWA	American Water Works Association
CGA	Compressed Gas Association
CSA	Canadian Standards Association
CISPI	Cast Iron Soil Pipe Institute
EJMA	Expansion Joint Manufacturing Association
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
HIS	Hydraulic Institute Standards
IEEE	Institute of Electrical and Electronics Engineers
IRI	Industrial Risk Insurers
ISO	Insurance Services Office
MCAA	Mechanical Contractors Association of America
NBS	National Bureau of Standards
NEBB	National Environmental Balancing Bureau
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NOFI	National Oil Fuel Institute
NSC	National Safety Council
NSF	National Sanitation Foundation
OSHA	Occupational Safety and Health Administration
PDI	Plumbing and Drainage Institute
SDWA	Safe Drinking Water Act
SMACNA	Sheet Metal and Air Conditioning Contractors National Association
STI	Steel Tank Institute
UL	Underwriters' Laboratories

D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.



- E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

#### 1.8 PERMITS AND FEES

- A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

#### 1.9 EQUIPMENT SUBSTITUTIONS

- A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.
- B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.
- C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.
- D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.



- E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.
  
- F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.
  
- G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
  - 1. The equivalent shall have the same construction features such as, but not limited to:
    - a. Material thickness, gauge, weight, density, etc.
    - b. Welded, riveted, bolted, etc., construction
    - c. Finish, undercoating, corrosion protection
  - 2. The equivalent shall perform with the same or better operating efficiency.
  - 3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  - 4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.
  
- H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
  - 1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
  - 2. Submit three (3) copies of each request for substitution for consideration.
  - 3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
    - b. Samples, where applicable or requested.
    - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.

- d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
- e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
- f. Cost information, including a proposal of the net change, if any in the Contract Sum.
- g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
- h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
- i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
  - 1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.
  - 2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
  - 3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

#### 1.10 SUBMITTAL PROCEDURES

- A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.

- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
  2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
  2. If an intermediate submittal is necessary, process the same as the initial submittal.
  3. Allow two weeks for reprocessing each submittal.
  4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
1. Include the following information on the label for processing and recording action taken.
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Number, title and paragraph of appropriate Specification Section.
    - i. Drawing number and detail references, as appropriate.
- E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

- F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.
- G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

#### 1.11 SHOP DRAWINGS

- A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to Division 1 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.
- C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.
- D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.
- E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- G. "No Exception Taken" rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way

relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.

- H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.
- I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.
- K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.
- L. Prepare plumbing shop drawings drawn in the latest AutoCAD version to a minimum scale of 1/4" = 1'-0". Final approved drawings shall be turned over to the Owner on CD Rom, flash drive or other electronic version.

#### 1.12 COORDINATION DRAWINGS

- A. Prepare coordination drawings drawn in the latest AutoCAD and BIM version in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
    - a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
    - b. Equipment connections and support details.
    - c. Exterior wall and foundation penetrations.
    - d. Fire-rated wall and floor penetrations.
    - e. Sizes and locations of required concrete pads and bases.
- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.

- D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.
- F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.
- G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files an Electronic Drawing File Release Form must be submitted. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic Drawing File Release Form, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the Electronic Drawing File Release Form is appended to the end of this specification section

#### 1.13 COORDINATION WITH OTHER DIVISIONS

- A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.
- B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.
- C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.
- D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

#### 1.14 WORKMANSHIP

- A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.



- B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.
- D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- E. All labor for installation of plumbing systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

#### 1.15 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.
- B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

#### 1.16 TEMPORARY UTILITIES

- A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.
- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. First Aid Supplies: Comply with governing regulations.

- D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
- E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
  - 1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
- F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.
- G. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building's permanent HVAC systems shall not be used for these purposes.
- H. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.
- I. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

#### 1.17 PROJECT PHASING

- A. Work under each Section shall include all necessary temporary connections, equipment, piping, heating, temperature control work, fire stopping, water heaters, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required



to maintain existing systems operational or to accommodate the construction phasing of the project.

#### 1.18 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

#### 1.19 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer.

#### 1.20 CLEANING

- A. The Contractor shall thoroughly clean and flush all piping and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.
- B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of

removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

- C. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.
- E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
  - 1. Remove labels that are not permanent labels.
  - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
  - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
  - 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
- F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.
- G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

#### 1.21 OPERATING AND MAINTENANCE

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.
- B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.

- C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; controls, water heaters, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

#### 1.22 OPERATING AND MAINTENANCE MANUALS

- A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.
- B. Manual shall include the following:
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing and operating instructions including lubrication charts and schedules.
  - 5. Emergency and safety instructions.
  - 6. Spare parts list.
  - 7. Copies of warranties.
  - 8. Wiring diagrams.
  - 9. Recommended "turn around" cycles.
  - 10. Inspection procedures.
  - 11. Approved Shop Drawings and Product Data.
  - 12. Equipment Start-up Reports.
  - 13. Temperature control diagrams and written sequences of operations.
  - 14. Balance reports.
- C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

- D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

#### 1.23 ACCEPTANCES

- A. The equipment, materials, workmanship, design and arrangement of all work installed under the Plumbing Sections shall be subject to the review of the Engineer.
- B. Within 30 days after the awarding of a Contract, the Plumbing Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Plumbing Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner's representative.
- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Plumbing Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

#### 1.24 RECORD DRAWINGS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.
- B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
  - 1. Dimensional change

2. Revision to drawing detail
  3. Location and depth of underground utility
  4. Revision to pipe routing
  5. Revision to electrical circuitry
  6. Actual equipment location
  7. Pipe size and routing
  8. Location of concealed internal utility
  9. Changes made by Change Order
  10. Details not on original Contract Drawing
  11. Information on concealed elements which would be difficult to identify or measure later
- C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
- D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
- E. Note related Change Order numbers where applicable.
- F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
- G. Contractor shall be responsible for making all corrections in ACAD. Final record documents shall be prepared in the latest AutoCAD version. CD Rom, flash drive or other electronic version of all drawings and a clean set of hard copies shall be turned over to the Owner at the completion of the work.

#### 1.25 WARRANTIES AND BONDS

- A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
1. General close-out requirements included in Section 01 78 30 Warranties and Bonds.
  2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions-2 through -50.
  3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

- D. The contractor shall guarantee all materials and workmanship for a period of eighteen (18) months from the date of Substantial Completion of the Work. In addition, the Contractor shall furnish warranties listed. Submit four (4) copies of each to the Construction Administrator in the supplier's standard form or in the form given if there is no standard form available.

#### 1.26 WARRANTY REQUIREMENTS

- A. **Related Damages and Losses:** When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. **Reinstatement of Warranty:** When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. **Replacement Cost:** Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. **Owner's Recourse:** Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. **Rejection of Warranties:** The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.
- H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.

- I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
  - 1. Refer to individual Sections of Divisions-2 through -50 for specific content requirements, and particular requirements for submittal of special warranties.
- J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
  - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
  - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
  - 3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

#### 1.27 GUARANTEES

- A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.
- B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

#### 1.28 PROJECT CLOSE-OUT

- A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.
- B. DEEP Equipment Forms: In addition to standard cut sheets for equipment, provide separate listing of all equipment along with tag, description, capacity ratings, model #, Serial #, etc. Forms shall be submitted electronically in spread sheet format
- C. Deliver tools, spare parts, extra stock, and similar items.



- D. Complete start-up testing of systems, including measuring and documenting all required startup checklist requirements documented in installation and maintenance instructions by the equipment manufacturer, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- E. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- F. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
  - 1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
  - 2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION 220400



**Electronic Drawing File Release Form**

DELIVERY OF ELECTRONIC FILES FOR: \_\_\_\_\_  
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

\_\_\_\_\_  
Client's Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Company - Title

\_\_\_\_\_  
Architects' Signature

\_\_\_\_\_  
Date

\_\_\_\_\_  
Firm - Title

\_\_\_\_\_  
Owner's Signature

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Date

\_\_\_\_\_  
Company - Title

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SECTION 220500 COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Identification for Plumbing Piping and Equipment.
  - 2. Sleeves.
  - 3. Mechanical sleeve seals.
  - 4. Formed steel channel.
  
- B. Related Sections:
  - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  - 2. Section 22 04 00 – General Conditions for Plumbing Trades
  - 3. Section 22 05 00 – Common Work Results for Plumbing.
  - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  - 5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
  - 6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
  - 7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
  - 8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  - 9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
  - 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  - 11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  - 12. Section 22 07 00 – Plumbing Insulation.
  - 13. Section 22 11 23 – Facility Natural-Gas Piping.
  - 14. Section 22 21 23 – Plumbing Pumps.
  - 15. Section 22 40 00 – Plumbing Fixtures
  - 16. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 SUBMITTALS

- A. Shop Drawings: Submit for piping and equipment identification list of wording, symbols, letter size, and color coding for pipe identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
  
- B. Product Data for Pipe and Equipment Identification: Submit for mechanical identification manufacturers catalog literature for each product required.
  
- C. Samples for Pipe and Equipment Identification: Submit two tags, 1-1/2 inches in size. Submit two labels, 1.9 x 0.75 inches in size.

1.3 QUALITY ASSURANCE

- A. Maintain one copy of each document on site.

1.4 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

- A. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.
- B. Plastic Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.
- E. Plastic Underground Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

2.2 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Acrylic; refer to Section 07 90 00.

2.3 MECHANICAL SLEEVE SEALS

- A. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

2.4 FORMED STEEL CHANNEL

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. B-Line Systems
  - 3. Unistrut Corp.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION - PIPING AND EQUIPMENT IDENTIFICATION

- A. Install plastic nameplates with adhesive.
- B. Install plastic tags with corrosion resistant metal chain.

3.3 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with stuffing firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install chrome plated steel plastic stainless steel escutcheons at finished surfaces.

END OF SECTION 220500

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SECTION 220503 PIPES AND TUBES FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: Pipe and pipe fittings for the following systems:
1. Domestic water piping, within 5 feet of building.
  2. Sanitary sewer and vent piping within 5 feet of building.
  3. Storm water piping, within 5 feet of building.
  4. Equipment drains and over flows.
  5. Unions and flanges.
  6. Underground pipe markers.
  7. Bedding and cover materials.
- B. Related Sections:
1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  2. Section 22 04 00 – General Conditions for Plumbing Trades
  3. Section 22 05 00 – Common Work Results for Plumbing.
  4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
  6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
  7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
  8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
  10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  12. Section 22 07 00 – Plumbing Insulation.
  13. Section 22 11 23 – Facility Natural-Gas Piping.
  14. Section 22 21 23 – Plumbing Pumps.
  15. Section 22 40 00 – Plumbing Fixtures
  16. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
1. ASME B16.1 - Cast Iron Pipe Flanges and Flanged Fittings.
  2. ASME B16.3 - Malleable Iron Threaded Fittings.
  3. ASME B16.4 - Gray Iron Threaded Fittings.
  4. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
  5. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  6. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings (DWV).
  7. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes.

8. ASME B16.29 - Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
  9. ASME B31.9 - Building Services Piping.
  10. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
  11. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. ASTM International:
1. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings.
  2. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  3. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings.
  4. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
  5. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
  6. ASTM A536 - Standard Specification for Ductile Iron Castings.
  7. ASTM B32 - Standard Specification for Solder Metal.
  8. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes.
  9. ASTM B43 - Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
  10. ASTM B75 - Standard Specification for Seamless Copper Tube.
  11. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
  12. ASTM B251 - Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
  13. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
  14. ASTM B302 - Standard Specification for Threadless Copper Pipe, Standard Sizes.
  15. ASTM B306 - Standard Specification for Copper Drainage Tube (DWV).
  16. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
  17. ASTM C14 - Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
  18. ASTM C76 - Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
  19. ASTM C443 - Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
  20. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
  21. ASTM C1053 - Standard Specification for Borosilicate Glass Pipe and Fittings for Drain, Waste, and Vent (DWV) Applications.
  22. ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
  23. ASTM D2464 - Standard Specification for Threaded Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  24. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.



25. ASTM D2467 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
  26. ASTM D2513 - Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
  27. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
  28. ASTM D2665 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
  29. ASTM D2680 - Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite Sewer Piping.
  30. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
  31. ASTM D2729 - Standard Specification for Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  32. ASTM D2855 - Standard Practice for Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
  33. ASTM D3034 - Standard Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
  34. ASTM D3139 - Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
  35. ASTM F679 - Standard Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
  36. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
  2. AWS D1.1 - Structural Welding Code - Steel.
- D. American Water Works Association:
1. AWWA C104 - American National Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
  2. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
  3. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
  4. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  5. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
  6. AWWA C900 - Polyvinyl Chloride (PVC) Pressure Pipe, 4 in. through 12 in., for Water Distribution.

- E. Cast Iron Soil Pipe Institute:
  - 1. CISPI 301 - Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
  - 2. CISPI 310 - Specification for Coupling for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
- F. NSF International:
  - 1. NSF 61 - Standard for Drinking Water System Components - Health Effects.
- G. Safe Drinking Water Act.
  - 1. SDWA 1417 - Standard for Lead Free Drinking Water.

### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of piping systems, including equipment, critical dimensions, and sizes.
- C. Product Data: Submit data on pipe materials and fittings. Submit manufacturers catalog information. Clearly indicate on submittal "Lead Free" where required.
- D. Design Data: Indicate pipe sizes. Indicate pipe sizing methods. Indicate calculations used. Submit sizing methods and calculations sealed by registered professional engineer.
- E. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.

### 1.4 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the cast iron soil pipe institute.
- C. All couplings for hubless cast iron soil pipe and fittings shall meet the requirements of CISPI 310 and be certified by NSF International.
- D. All components of the potable domestic water system shall meet the requirements of SDWA-1417.
- E. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic or an Engineer Approved Equal. Grooving tools shall be supplied by the same manufacturer as the grooved components

- F. Maintain one copy copies of each document on site.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum 3 years documented experience.
- C. Design piping systems pipe hangers and supports under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

#### 1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Furnish temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.

#### 1.8 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Requirements for warranties.

#### 1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install underground piping when bedding is wet or frozen.

#### 1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.11 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Requirements for coordination.
- B. Coordinate installation of buried piping with trenching.

PART 2 PRODUCTS

2.1 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Ductile Iron Pipe: AWWA C151 C104
  - 1. Fittings: AWWA C110, ductile iron, standard thickness.
  - 2. Joints: AWWA C111, rubber gasket with rods.
  - 3. Jackets: AWWA C105 polyethylene jacket Double layer, half lapped, 10 mil polyethylene tape.

2.2 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tubing: ASTM B88, Type L drawn.
  - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
  - 2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder
- B. Copper Tubing: ASTM B88, Type L, drawn.
  - 1. Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper and bronze or extruded tee connections conforming to ASTM F2014-00.
  - 2. Joints: ASTM B32, solder, Grade 95TA or extruded tee connections brazed in compliance with the manufacturer's written instructions.
  - 3. Other Acceptable Joining Methods:
    - a. Victaulic Copper Connection System sizes 2" to 8" with Victaulic style 607 coupling for copper tubing.
      - 1) Grooved Fittings: ASME B16.18, cast bronze, or ASME B16.22, wrought copper, with copper-tubing sized grooved ends. (Flaring of tube or fittings ends to IPS sizes is not permitted.
      - 2) Style 607 coupling with offsetting, angle-pattern bolt pads for direct metal-to-metal bolt pad contact with no torque requirement.
      - 3) Gaskets shall be grade 'EHP' EPDM, UL classified in accordance with ANSI/NSF-61 for potable water service.
    - b. Press Fitting: Copper and copper alloy press fittings conforming to ASME B16.18 or ASME B16.22. Sealing elements for press fittings shall be EPDM and factory installed. Press ends shall have SC feature design (leakage path) to assure detection and easy identification of leakage of liquids from inside the system past the sealing element of an unpressed connection.

2.3 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. PVC Pipe: ASTM D2729, polyvinyl chloride (PVC) material, bell and spigot solvent sealed ends.
  - 1. Fittings: PVC, ASTM D2729.
  - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.
- B. PVC Pipe: ASTM D3034 SDR 35 polyvinyl chloride (PVC) material.
  - 1. Fittings: ASTM D3034, PVC.
  - 2. Joints: ASTM F477, elastomeric gaskets.

2.4 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
  - 1. Fittings: Cast iron, ASTM A74.
  - 2. Joints: ASTM C564, rubber gasket joint devices or lead and oakum.
- B. Cast Iron Pipe: CISPI 301, hub-less, service weight.
  - 1. Fittings: Cast iron, CISPI 301.
  - 2. Joints: CISPI 310, neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.5 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: CISPI 301, hubless, service weight.
  - 1. Fittings: Cast iron, CISPI 301.
  - 2. Joints: Neoprene gaskets and stainless steel clamp-and-shield assemblies.

2.6 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.
  - 1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
  - 2. Joints: Threaded for pipe 2 inch and smaller; flanged for pipe 2-1/2 inches and larger.
- B. Copper Tubing: ASTM B88, Type K, L, M, drawn.
  - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
  - 2. Joints: ASTM B32, Alloy Grade Sb5 tin-antimony, or Alloy Grade Sn95 tin-silver, lead free solder.
- C. PVC Pipe: ASTM D1785, Schedule 40, and Schedule 80 for sizes 8 inch and larger, or ASTM D2241, SDR 21 or 26, polyvinyl chloride (PVC) material.
  - 1. Fittings: ASTM D2466, Schedule 40, PVC ASTM D2467, Schedule 80, PVC ASTM D2464 PVC, threaded.
  - 2. Joints: ASTM D2855, solvent weld with ASTM D2564 solvent cement.

## 2.7 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
  - 1. Ferrous Piping: Class 150 250 300, malleable iron, threaded.
  - 2. Copper Piping: Class 150, bronze unions with soldered brazed joints.
  - 3. Dielectric Connections: Union or waterways with galvanized or plated steel or copper-silicon casting with threaded end, copper solder end, grooved end, lead free, water impervious isolation barrier.
  - 4. PVC Piping: PVC.
  
- B. Flanges for Pipe 2-1/2 inches and Larger:
  - 1. Ferrous Piping: Class 150 250 300, forged steel, slip-on flanges or grooved joint flange adapters.
  - 2. Copper Piping: Class 150, slip-on bronze flanges or grooved joint flange adapters.
  - 3. PVC Piping: PVC flanges.
  - 4. Gaskets: 1/16 inch thick preformed neoprene gaskets.
  - 5. Dielectric Connections: Waterways with galvanized or plated steel or copper-silicon casting with grooved end, lead free, water impervious isolation barrier
  
- C. PVC Pipe Materials: For connections to equipment and valves with threaded connections, furnish solvent-weld socket to screwed joint adapters and unions, or ASTM D2464, Schedule 80, threaded, PVC pipe.

## 2.8 UNDERGROUND PIPE MARKERS

- A. Manufacturers:
  - 1. Seton
  - 2. Northtown
  - 3. Kolbi
  - 4. Substitutions: Section 01 60 00 - Product Requirements Not Permitted.
  
- B. Plastic Ribbon Tape: Bright colored, continuously printed, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
  
- C. Trace Wire (when plastic pipe material is used): Magnetic detectable conductor, brightly colored plastic covering, imprinted with "Domestic Water Service Sewer Service in large letters.

## 2.9 BEDDING AND COVER MATERIALS

- A. Soil Backfill from Above Pipe to Finish Grade: Soil Type as specified in Division 31 Subsoil with no rocks over 6 inches in diameter, frozen earth or foreign matter.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify excavations are to required grade, dry, and not over-excavated.
- C. Verify trenches are ready to receive piping.

#### 3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel or groove plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

#### 3.3 INSTALLATION - BURIED PIPING SYSTEMS

- A. Verify connection to existing piping system size, location, and invert are as indicated on Drawings.
- B. Excavate pipe trench in accordance with Division 31.
- C. Install pipe to elevation as indicated on Drawings
- D. Place bedding material at trench bottom to provide uniform bedding for piping, level bedding materials in one continuous layer not exceeding 4 inches compacted depth; compact to 95 percent maximum density.
- E. Install pipe on prepared bedding.
- F. Route pipe in straight line.
- G. Establish invert elevations, slopes for drainage to  $\frac{1}{4}$  for piping 2  $\frac{1}{2}$ " and smaller,  $\frac{1}{8}$  inch per foot minimum for piping 3" and larger. Maintain gradients.
- H. Install pipe to allow for expansion and contraction without stressing pipe or joints.
- I. Install shutoff and drain valves at locations indicated on Drawings in accordance with Section 22 05 23

- J. Pipe Cover and Backfilling:
    - 1. Backfill trench in accordance with Division 31.
    - 2. Maintain optimum moisture content of fill material to attain required compaction density.
    - 3. After hydrostatic test, evenly backfill entire trench width by hand placing backfill material and hand tamping in 6 inches compacted layers to 6 inches minimum cover over top of jacket. Compact to 95 percent maximum density.
    - 4. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.
    - 5. Do not use wheeled or tracked vehicles for tamping.
- 3.4 INSTALLATION - ABOVE GROUND PIPING
- A. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
  - B. Install piping to maintain headroom without interfering with use of space or taking more space than necessary.
  - C. Group piping whenever practical at common elevations.
  - D. Sleeve pipe passing through partitions, walls and floors. Refer to Section 22 05 29.
  - E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 05 16.
  - F. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 07 00.
  - G. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Division 08.
  - H. Install non-conducting dielectric connections wherever jointing dissimilar metals.
  - I. Establish invert elevations, slopes for drainage to  $\frac{1}{4}$  for piping 2  $\frac{1}{2}$ " and smaller,  $\frac{1}{8}$  inch per foot minimum for piping 3" and larger. Maintain gradients.
  - J. Slope piping and arrange systems to drain at low points.
  - K. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
  - L. Install piping penetrating roofed areas to maintain integrity of roof assembly.
  - M. Install valves in accordance with Section 22 05 23.
  - N. Install piping specialties in accordance with Section 23 21 16.



- O. Insulate piping. Refer to Section 22 07 00.
- P. Install pipe identification in accordance with Section 22 05 53.

3.5 INSTALLATION - DOMESTIC WATER PIPING SYSTEMS

- A. Install domestic water piping system in accordance with SDWA - 1417.
- B. Install domestic water piping system in accordance with ASME B31.9.
- C. The plumbing contractor shall furnish and install hot and cold water supplies to all plumbing fixtures and equipment throughout the project. All piping shall be supplied from the water source, mains, and branch piping.
- D. Shut off valves shall be provided on all supply piping where more than two fixtures are provided. Valve type shall be as determined by the engineer or as indicated on the drawings and specifications.

3.6 INSTALLATION - SANITARY WASTE AND VENT PIPING SYSTEMS

- A. Install sanitary waste and vent piping systems in accordance with ASME B31.9.
- B. Install sanitary waste and vent piping systems in accordance with local plumbing code.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.
- E. Vent terminations shall extend 24" above the finished roof elevation.
- F. Vent terminations shall extend a minimum of 7'-0" above the finished roof elevation when the roof is use for other purposes beyond weather protection.
- G. Vent piping terminations shall not be located within 25'-0" of mechanical outdoor air intakes or louvers.
- H. Sanitary and vent piping shall be provided for all plumbing fixtures, devices and equipment throughout the project. All piping shall be installed in compliance with the adopted edition of the international Plumbing Code and State of Connecticut Amendments and Supplements.
- I. Vents from individual fixtures shall be combined and extend through the roof in multiple locations.
- J. Sanitary piping from individual fixtures, devices and equipment shall combine into multiple buried laterals and exit the building below finished grade and connect to the one site piping network.

- K. The plumbing contractor must review the site and civil drawings for coordination with piping systems beyond the building footprint.
- L. Furnish and install cleanouts at all changes in direction greater than 45 degrees and not more than 75' foot intervals for horizontal runs. Provide finished grade cleanouts at lateral exiting the building.
- M. The project includes multiple approved techniques for venting, including but not limited to wet venting, circuit venting, combination drain and vent and island fixture vents. The contractor shall install the vent system accordingly to comply with the adopted edition of the International Plumbing Code.

### 3.7 INSTALLATION - STORM DRAINAGE PIPING SYSTEMS

- A. Install storm drainage piping systems piping in accordance with ASME B31.9.
- B. Install storm drainage piping systems in accordance with local plumbing code.
- C. Install bell and spigot pipe with bell end upstream.
- D. Support cast iron drainage piping at every joint.
- E. Storm piping shall be furnished and installed to all roof drains, overflow drains and canopy drains throughout the project and shall be combined and exit the building below finished grade in multiple locations.
- F. Furnish and install cleanouts at all changes in direction greater than 45 degrees and not more than 75' foot intervals for horizontal runs. Provide finished grade cleanouts at lateral exiting the building.
- G. The plumbing contractor must review the site and civil drawings for coordination with piping systems beyond the building footprint.

### 3.8 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Test domestic water piping system in accordance with applicable code and local authority having jurisdiction
- C. Test sanitary waste and vent piping system in accordance with applicable code and local authority having jurisdiction
- D. Test storm drainage piping system in accordance with applicable code and local authority having jurisdiction

3.9 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean and disinfect domestic water distribution system in accordance with Section Division 31 and with the following
  1. Prior to starting work, verify system is complete, flushed and clean.
  2. Verify pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
  3. Inject disinfectant, free chlorine in liquid, powder and tablet or gas form, throughout system to obtain residual from 50 to 80 mg/L.
  4. Bleed water from outlets to obtain distribution and test for disinfectant residual at minimum 15 percent of outlets.
  5. Maintain disinfectant in system for 24 hours.
  6. When final disinfectant residual tests less than 25 mg/L, repeat treatment.
  7. Flush disinfectant from system until residual concentration is equal to incoming water or 1.0 mg/L.
  8. Take samples no sooner than 24 hours after flushing, from 10 to 25 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

END OF SECTION 220503

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SECTION 220513 COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections and for motors furnished loose to Project.
  
- B. Related Sections:
  - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  - 2. Section 22 04 00 – General Conditions for Plumbing Trades
  - 3. Section 22 05 00 – Common Work Results for Plumbing.
  - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  - 5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
  - 6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
  - 7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
  - 8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  - 9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
  - 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  - 11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  - 12. Section 22 07 00 – Plumbing Insulation.
  - 13. Section 22 11 23 – Facility Natural-Gas Piping.
  - 14. Section 22 21 23 – Plumbing Pumps.
  - 15. Section 22 40 00 – Plumbing Fixtures
  - 16. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
  - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
  
- B. National Electrical Manufacturers Association:
  - 1. NEMA MG 1 - Motors and Generators.
  
- C. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 PRODUCT REQUIREMENTS FOR MOTORS FURNISHED WITH EQUIPMENT

- A. Manufacturers:
  - 1. Cooper Industries Inc.
  - 2. Eaton Corp.
  - 3. General Electric Co.
- B. Motors 3/4 hp and Larger: Three-phase motor as specified below.
- C. Motors Smaller Than 3/4 hp: Single-phase motor as specified below, except motors less than 250 watts or 1/4 hp may be equipment manufacturer's standard.

- D. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds.
  - 1. Voltage: 208 230 230/460 460 volts, three phase, 60 Hz.
  - 2. Service Factor: As indicated on Drawings.
  - 3. Enclosure: Meet conditions of installation unless specific enclosure is indicated on Drawings.
  - 4. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
  - 5. Insulation System: NEMA Class F
  - 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
  - 7. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
  - 8. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
  - 9. Sound Power Levels: Conform to NEMA MG 1.
  
- E. Single Phase Motors:
  - 1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
  - 2. Voltage: 115 115/230 230 volts, single phase, 60 Hz.
  
- F. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.

## 2.2 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- B. Install engraved plastic nameplates in accordance with Section 26 05 53.
- C. Ground and bond motors in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION 220513



SECTION 220516 EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Flexible pipe connectors.
  - 2. Expansion joints.
  - 3. Expansion compensators.
  - 4. Pipe alignment guides.
  - 5. Swivel joints.
  - 6. Pipe anchors.
  
- B. Related Sections:
  - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  - 2. Section 22 04 00 – General Conditions for Plumbing Trades
  - 3. Section 22 05 00 – Common Work Results for Plumbing.
  - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  - 5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
  - 6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
  - 7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
  - 8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  - 9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
  - 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  - 11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  - 12. Section 22 07 00 – Plumbing Insulation.
  - 13. Section 22 11 23 – Facility Natural-Gas Piping.
  - 14. Section 22 15 00 – General Service Compressed-Air Systems.
  - 15. Section 22 21 23 – Plumbing Pumps.
  - 16. Section 22 34 00 – Fuel-Fired Domestic Water Heaters.
  - 17. Section 22 40 00 – Plumbing Fixtures
  - 18. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME B31.9 - Building Services Piping.
  - 2. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
  
- B. American Welding Society:
  - 1. AWS D1.1 - Structural Welding Code - Steel.

1.3 DESIGN REQUIREMENTS

- A. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.
- B. Expansion Compensation Design Criteria:
  - 1. Installation Temperature: 50 degrees F.
  - 2. Domestic Hot Water: 140 degrees F.
  - 3. Safety Factor: 30 percent.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints. Submit shop drawings sealed by a registered professional engineer. Include shop drawing information for piping expansion compensation in shop drawings for piping system specified in Section
- C. Product Data:
  - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- D. Design Data: Indicate criteria and show calculations. Submit sizing methods calculations sealed by a registered professional engineer.
- E. Manufacturer's Installation Instructions: Submit special procedures.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX. AWS D1.1.
- H. Manufacturer's Field Reports: Indicate results of inspection by manufacturer's representative.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- C. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. All pre-manufactured expansion fittings and loops installed on the domestic water system shall meet the requirements of SDWA 1417.
- C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.
- C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed at Project location.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
- C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.10 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for leak free performance of packed expansion joints.

1.11 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Supply two 12 ounce containers of packing lubricant and cartridge style grease gun.

PART 2 PRODUCTS

2.1 FLEXIBLE PIPE CONNECTORS

- A. Manufacturers:
  - 1. Metroflex
  - 2. Mason
  - 3. Vibration Eliminator
- B. Steel Piping:
  - 1. Inner Hose: Carbon Steel.
  - 2. Exterior Sleeve: Single braided .
  - 3. Pressure Rating: 200 psig WOG and 250 degrees F.
  - 4. Joint: As specified for pipe joints.
  - 5. Size: Use pipe-sized units.
  - 6. Maximum offset: 1 inch on each side of installed center line.
- C. Copper Piping:
  - 1. Inner Hose: Bronze.
  - 2. Exterior Sleeve: Braided bronze.
  - 3. Pressure Rating: 200 psig WOG and 250 degrees F.
  - 4. Joint: As specified for pipe joints.
  - 5. Size: Use pipe sized units.
  - 6. Maximum offset: 1 inch on each side of installed center line.
  - 7. Maximum lead content shall be.25%.

2.2 EXPANSION JOINTS

- A. Manufacturers:
  - 1. Metroflex
  - 2. Mason
  - 3. Vibration Eliminator
- B. Stainless Steel Bellows Type:
  - 1. Pressure Rating: 200 psig WOG and 250 degrees F.
  - 2. Maximum Compression: 3 inch.
  - 3. Maximum Extension: 1/4 inch.
  - 4. Joint: As specified for pipe joints.
  - 5. Size: Use pipe sized units.
  - 6. Application: Steel piping 3 inch and smaller.

- C. Copper with Packed Sliding Sleeve:
  - 1. Maximum Temperature: 250 degrees F.
  - 2. Joint: As specified for pipe joints.
  - 3. Size: Use pipe sized units.
  - 4. Copper or steel piping 2 inches and larger.
  - 5. Application: Copper or steel piping 2 inch and larger.

### 2.3 ACCESSORIES

- A. Manufacturers:
  - 1. Metroflex
  - 2. Mason
  - 3. Vibration Eliminator
- B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.
- C. Swivel Joints: Fabricated steel Bronze Ductile Iron Cast steel body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.9
- B. Install flexible pipe connectors on pipes connected to equipment supported by vibration isolation. Refer to Section 22 05 48. Provide line size flexible connectors.
- C. Install flexible connectors at right angles to displacement. Install one end immediately adjacent to isolated equipment and anchor other end. Install in horizontal plane unless indicated otherwise.
- D. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.
- E. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required as indicated on Drawings. Refer to Section 22 05 29 for pipe hanger installation requirements.
- F. Provide grooved piping systems with minimum three flexible couplings per flexible connector supported by vibration isolation.
- G. Provide expansion loops as indicated on Drawings.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.
- B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 220516

SECTION 220523 GENERAL DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Gate valves.
2. Ball valves.
3. Butterfly valves.
4. Check valves.
5. Globe valves.
6. Pressure reducing.
7. Pressure relief.
8. Strainers.
9. Flow control devices.
10. Balancing valves.
11. Reduced pressure backflow preventers.
12. Thermostatic mixing valves

B. Related Sections:

1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 00 – Common Work Results for Plumbing.
4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
12. Section 22 07 00 – Plumbing Insulation.
13. Section 22 11 23 – Facility Natural-Gas Piping.
14. Section 22 21 23 – Plumbing Pumps.
15. Section 22 40 00 – Plumbing Fixtures
16. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

A. Manufacturers Standardization Society of the Valve and Fittings Industry:

1. MSS SP 67 - Butterfly Valves.
2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.

5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
  6. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
- B. Safe Drinking Water Act:
1. SDWA 1417 - Reduction of Lead in Drinking Water.

### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

### 1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of valves
- C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

### 1.5 QUALITY ASSURANCE

- A. For drinking water service, provide valves complying with NSF 61.
- B. All valves installed on the domestic water distribution system shall comply with SDWA 1417. Exception shall be main shut-off valve at domestic water service entrance that is 2-inches or larger.
- C. All valve manufacturers shall demonstrate that valve products have been certified per NSF/ANSI Standard 372.
- D. All valves installed on the domestic water system shall have labeling of lead content engraved on the valve body.
- E. Maintain one copy of each document on site.
- F. To assure uniformity and compatibility of piping components in grooved end piping systems, all grooved products utilized shall be supplied by Victaulic or an Engineer Approved Equal



1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install valves underground when bedding is wet or frozen.

1.10 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Requirements for warranties.
- B. Furnish five year manufacturer warranty for valves excluding packing.

1.11 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for extra materials.
- B. Furnish two packing kits for each size valve.

## PART 2 PRODUCTS

### 2.1 GATE VALVES

- A. Manufacturers:
  - 1. Apollo
  - 2. Milwaukee Valve Co.
  - 3. NIBCO, Inc.
  - 4. American Valve Co.
  - 5. Watts
  - 6. Kitz
  
- B. 2 inches and Smaller: MSS SP 80, Class 300, bronze body, bronze trim, lead free, threaded bonnet, non-rising stem, hand-wheel, inside screw, solid wedge disc, solder ends.
  
- C. 2 1/2 inches and Larger: MSS SP 70, Class 175, cast iron body, bronze trim, bolted bonnet, rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

### 2.2 BALL VALVES

- A. Manufacturers:
  - 1. Apollo
  - 2. Milwaukee Valve Co.
  - 3. NIBCO, Inc.
  - 4. American Valve Co.
  - 5. Watts
  - 6. Kitz
  
- B. 2 inches and Smaller: MSS SP 110, 600 psi WOG, two piece bronze body, lead free, type 316 stainless steel ball, full port, teflon seats, stainless steel blow-out proof stem, solder ends with lever handle.
  
- C. 2 inches and Smaller: MSS SP 110, Class 600, bronze, three piece body, lead free, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder ends, lever handle.
  
- D. 2 inches and Smaller: MSS SP 110, Class 250, bronze, two piece body, lead free, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, press ends, lever handle.

## 2.3 BUTTERFLY VALVES

- A. Manufacturers:
  - 1. Victaulic
  - 2. Milwaukee Valve Company
  - 3. NIBCO, Inc.
  - 4. American Valve Co.
  - 5. Watts
  - 6. Kitz
  
- B. 2-inches and Larger: MSS SP 67, Class 200.
  - 1. Body: Cast bronze, lug ends, stainless steel stem, extended neck.
  - 2. Disc: Aluminum bronze.
  - 3. Seat: Resilient replaceable EPDM or Fluoroelastomer.
  - 4. Handle and Operator: 10 position lever handle. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.
  
- C. 2-inches and Larger: MSS SP 67, Class 200.
  - 1. Body: Ductile iron, lug ends, stainless steel stem, extended neck.
  - 2. Disc: Aluminum bronze.
  - 3. Seat: Resilient replaceable EPDM.
  - 4. Handle and Operator: 10 position lever handle. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.
  - 5. Lead free.
  
- D. 2-1/2 inches and Larger: MSS SP 67, 300 CWP.
  - 1. Body: Cast bronze, grooved ends
  - 2. Disc: Offset ductile iron
  - 3. Seat: Resilient replaceable Fluoroelastomer
  - 4. Handle and Operator: 10 position lever handle. Furnish chain-wheel operators for valves mounted over 8 feet above floor

## 2.4 CHECK VALVES

- A. Horizontal Swing Check Valves:
  - 1. Manufacturers:
    - a. Apollo
    - b. Milwaukee Valve Co.
    - c. NIBCO, Inc.
    - d. American Valve Co.
    - e. Watts
    - f. Kitz
  - 2. 2 inches and Smaller: MSS SP 80, Class 300, bronze body and cap, bronze seat, brass disc, solder ends.
  - 3. 2-1/2 inches and Larger: MSS SP 71, Class 125 cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.

- B. Spring Loaded Check Valves:
  - 1. Manufacturers:
    - a. Apollo
    - b. Milwaukee Valve Company
    - c. NIBCO, Inc.
    - d. American Valve Co.
    - e. Watts
  - 2. 2 inches and Smaller: MSS SP 80, Class 250 bronze body, in-line spring lift check, silent closing, Buna-N teflon disc, integral seat, solder or threaded ends. 1)
  - 3. 2-1/2 inches and Larger: MSS SP 125, Class 125, lead free, wafer style, cast iron body, bronze seat, center guided bronze disc, stainless steel spring and screws, flanged ends.

## 2.5 GLOBE VALVES

- A. Manufacturers:
  - 1. Apollo
  - 2. Milwaukee Valve Co.
  - 3. NIBCO, Inc.
  - 4. American Valve Co.
  - 5. Watts
  - 6. Kitz
- B. Up to and including 2-inch:
  - 1. Bronze body, bronze trim, screwed bonnet, non-asbestos packing, rising stem, handwheel, inside screw, renewable composition disc and bronze seat, Class 125.
- C. Over 2-inch:
  - 1. Iron body, bronze trim, bolted bonnet, rising stem, non-asbestos packing, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, Class 125, flanged ends, MSS-SP-85. Provide chain wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

## 2.6 WATER PRESSURE REDUCING VALVES

- A. Manufacturers:
  - 1. Apollo
  - 2. Milwaukee Valve Co.
  - 3. NIBCO, Inc.
  - 4. Watts
- B. Up to 2 Inches (50 mm): Bronze body, stainless steel and thermoplastic internal parts, fabric reinforced diaphragm, threaded ends, with strainer.
- C. Over 2 Inches (50 mm): Cast iron body, bronze fitted, elastomeric diaphragm and seat disc, flanged, with strainer, MSS-SP-80.

## 2.7 TEMPERATURE AND PRESSURE RELIEF VALVES

- A. Manufacturers:
  - 1. Apollo
  - 2. Milwaukee Valve Co.
  - 3. NIBCO, Inc.
  - 4. Watts
  
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

## 2.8 STRAINERS

- A. Manufacturers:
  - 1. Apollo
  - 2. Milwaukee Valve Co.
  - 3. NIBCO, Inc.
  - 4. Watts
  
- B. Watts series 77:
  - 1. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
  - 2. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged cast iron body, Class 125 for 200 psig (1370 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.

## 2.9 FLOW CONTROL VALVES

- A. Manufacturers:
  - 1. FDI.
  - 2. Nexus.
  - 3. Grissold,
  - 4. Macon.
  
- B. FDI Series ICSS.
  - 1. Construction: series 300 stainless steel body with nickel plated union nut.
  - 2. Threaded inlet and outlet connection.
  - 3. Automatic flow cartridge, stainless steel with machined piston, stainless steel spring, factory set calibration.
  - 4. Maximum operating temperature: 180 degrees F.
  - 5. NSF 61 certification.

## 2.10 BALANCING VALVES

- A. Construction: Brass or bronze body wye arrangement with union on inlet, temperature and pressure test plug on inlet and outlet.

- B. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control.

#### 2.11 BACKFLOW PREVENTERS

- A. Reduced Pressure Backflow Preventers: ANSI/ASSE 1013, AWWA C506; two independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; test cocks, Watts as scheduled or approved equal by Viking, Stockham or Milwaukee.

#### 2.12 THERMOSTATIC MIXING VALVES

- A. Acceptable manufacturers offer equivalent products:
  - 1. Lawler
  - 2. Bradley
  - 3. Symmons
  - 4. Watts
- B. Temp control thermostatic controller with swivel action check stops, removable cartridge with strainer, stainless steel piston and liquid filled motor with bellows mounted out of water, rough brass finish
- C. Valve body: lead free bronze or brass.
- D. Cabinet: 16 gage (1.5 mm) prime coated steel, for recessed surface mounting with keyed lock.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping system is ready for valve installation.

#### 3.2 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install 3/4 inch gate ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- D. Install valves with clearance for installation of insulation and allowing access.

- E. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.
- F. Refer to Section 22 07 00 for insulation requirements for valves.
- G. Refer to Section 22 05 03 for piping materials applying to various system types.

### 3.3 VALVE APPLICATIONS

- A. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.
- B. Install ball butterfly or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install ball butterfly or globe valves for throttling, bypass, or manual flow control services.
- D. Install spring loaded check valves on discharge of water pumps.
- E. Install lever and weight lever and spring check valves on discharge of pumps in pumped sanitary pumped storm water piping.
- F. Install lug or grooved end butterfly valves adjacent to equipment when functioning to isolate equipment.
- G. Install flow control valves at the remote part of the domestic hot water return system. Valve size shall be minimum of 3/4-inch
- H. Provide line sized isolation valves on all domestic water branches greater than 3/4" when more than two fixtures are supplied.
- I. Install ball butterfly and gate valves in domestic water systems for shut-off service.
- J. Install ball and butterfly valves in domestic water systems for throttling service.

END OF SECTION 220523

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SECTION 220529 HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Flashing.
5. Sleeves.
6. Mechanical sleeve seals.
7. Formed steel channel.
8. Firestopping relating to plumbing work.
9. Firestopping accessories.
10. Equipment bases and supports.

B. Related Sections:

1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 00 – Common Work Results for Plumbing.
4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
12. Section 22 07 00 – Plumbing Insulation.
13. Section 22 11 23 – Facility Natural-Gas Piping.
14. Section 22 15 00 – General Service Compressed-Air Systems.
15. Section 22 21 23 – Plumbing Pumps.
16. Section 22 34 00 – Fuel-Fired Domestic Water Heaters.
17. Section 22 40 00 – Plumbing Fixtures
18. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B31.1 - Power Piping.
2. ASME B31.5 - Refrigeration Piping.
3. ASME B31.9 - Building Services Piping.

- B. ASTM International:
  - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
  - 3. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
  - 4. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
  - 5. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
  
- C. American Welding Society:
  - 1. AWS D1.1 - Structural Welding Code - Steel.
  
- D. FM Global:
  - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
  
- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
  - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
  - 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
  - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
  
- F. Underwriters Laboratories Inc.:
  - 1. UL 263 - Fire Tests of Building Construction and Materials.
  - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
  - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
  - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
  - 5. UL - Fire Resistance Directory.
  
- G. Intertek Testing Services (Warnock Hersey Listed):
  - 1. WH - Certification Listings.

### 1.3 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

### 1.4 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119 ASTM E814 UL 263 UL 1479 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating.
  
- B. Firestopping Materials: ASTM E119, ASTM E814, UL 263, UL 1479, to achieve fire ratings of adjacent construction in accordance with FM UL.
  
- C. Firestop interruptions to fire rated assemblies, materials, and components.

1.5 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code FM UL WH for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
- C. Product Data:
  - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
  - 2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers. Submit sizing methods calculations sealed by a registered professional engineer.
- F. Manufacturer's Installation Instructions:
  - 1. Hangers and Supports: Submit special procedures and assembly of components.
  - 2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgements: For conditions not covered by UL or WH listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
  - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.
  - 2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.

- a. Floor Penetrations within Wall Cavities: T-Rating is not required.
  
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
  - 1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
  - 2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
  
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
  
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
  
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
  
- F. Perform Work in accordance with applicable authority AWS D1.1 for welding hanger and support attachments to building structure.
  
- G. Maintain one copy of each document on site.
  
- H. High Performance Building Requirements:
  - 1. Adhesives, sealants, paints or coatings used for work in this section for interior applications shall meet the requirements of Division 1, Section 018113: "Volatile Organic Compound (VOC) Limits for Adhesives, Sealants, Paints and Coatings", where applicable.
  - 2. Materials manufactured within a radius of 500 miles from the project site where all or a portion of the raw resources also originate within a radius of 500 miles shall be documented in accordance with the High Performance Building Requirements of this Section.
  - 3. Materials that contain recycled content shall be documented in accordance with the High Performance Building Requirements of this Section.

## 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
  
- B. Installer: Company specializing in performing Work of this section with minimum 3 years documented experience.

1.9 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
- C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.
- D. Provide ventilation in areas to receive solvent cured materials.

1.12 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.13 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for pipe hangers and supports.

PART 2 PRODUCTS

2.1 PIPE HANGERS AND SUPPORTS

- A. Manufacturers:
  - 1. Nibco
  - 2. Empire
  - 3. Flex-Weld, Inc.

4. Glope Pipe Hanger Products Inc.
  5. Michigan Hanger Co.
  6. Superior Valve Co.
- B. Plumbing Piping - DWV:
1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
  2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.
  3. Hangers for Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
  4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  5. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
  6. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
  7. Vertical Support: Steel riser clamp.
  8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  9. Copper Pipe Support: Copper-plated, carbon-steel adjustable, ring.
- C. Plumbing Piping - Water:
1. Conform to ASME B31.9 ASTM F708 MSS SP58 MSS SP69 MSS SP89.
  2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron Carbon steel, adjustable swivel, split ring.
  3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
  4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
  5. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
  6. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hook.
  7. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
  8. Vertical Support: Steel riser clamp.
  9. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  10. Floor Support for Hot Pipe Sizes 4 inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
  11. Copper Pipe Support: Copper-plated, Carbon-steel ring.

## 2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

## 2.3 INSERTS

- A. Manufacturers:
1. Thunderline
  2. Link Seal
  3. Fernco
  4. BWM

- B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

#### 2.4 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
  - 1. Waterproofing: 5 lb./sq. ft sheet lead.
  - 2. Soundproofing: 1 lb./sq. ft sheet lead.
- D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

#### 2.5 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sealant: Acrylic; refer to Section 07 90 00.

#### 2.6 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
  - 1. Thunderline Link-Seal, Inc.
  - 2. NMP Corporation
  - 3. Fernco
  - 4. BWM Model
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

#### 2.7 FORMED STEEL CHANNEL

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. B-Line Systems
  - 3. Midland Ross Corporation, Electrical Products Division
  - 4. Unistrut Corp.
- B. Product Description: Galvanized 12 gage) thick steel. With holes 1-1/2 inches on center.

## 2.8 FIRESTOPPING

- A. Manufacturers:
  - 1. Dow Corning Corp.
  - 2. Fire Trak Corp.
  - 3. Hilti Corp.
  - 4. International Protective Coating Corp.
  - 5. 3M fire Protection Products
  - 6. Specified Technology, Inc.
  
- B. Product Description: Different types of products by multiple manufacturers are acceptable as required to meet specified system description and performance requirements; provide only one type for each similar application.
  - 1. Silicone Firestopping Elastomeric Firestopping: Single component silicone elastomeric compound and compatible silicone sealant.
  - 2. Foam Firestopping Compounds: Single component foam compound.
  - 3. Formulated Firestopping Compound of Incombustible Fibers: Formulated compound mixed with incombustible non-asbestos fibers.
  - 4. Fiber Stuffing and Sealant Firestopping: Composite of mineral fiber stuffing insulation with silicone elastomer for smoke stopping.
  - 5. Mechanical Firestopping Device with Fillers: Mechanical device with incombustible fillers and silicone elastomer, covered with sheet stainless steel jacket, joined with collars, penetration sealed with flanged stops.
  - 6. Intumescent Firestopping: Intumescent putty compound which expands on exposure to surface heat gain.
  - 7. Firestop Pillows: Formed mineral fiber pillows.
  
- C. Color: As selected from manufacturer's full range of colors.

## 2.9 FIRESTOPPING ACCESSORIES

- A. Primer: Type recommended by firestopping manufacturer for specific substrate surfaces and suitable for required fire ratings.
  
- B. Dam Material: Permanent:
  - 1. Mineral fiberboard.
  - 2. Mineral fiber matting.
  - 3. Sheet metal.
  - 4. Plywood or particle board.
  - 5. Alumina silicate fire board.
  
- C. Installation Accessories: Provide clips, collars, fasteners, temporary stops or dams, and other devices required to position and retain materials in place.
  
- D. General:
  - 1. Furnish UL listed products or products tested by independent testing laboratory.
  - 2. Select products with rating not less than rating of wall or floor being penetrated.



- E. Non-Rated Surfaces:
  - 1. Stamped steel, chrome plated, hinged, split ring escutcheons or floor plates or ceiling plates for covering openings in occupied areas where piping is exposed.
  - 2. For exterior wall openings below grade, furnish mechanical sealing device to continuously fill annular space between piping and cored opening or water-stop type wall sleeve.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

#### 3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Install damming materials to arrest liquid material leakage.
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- E. Obtain permission from Architect/Engineer before drilling or cutting structural members.

#### 3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1 ASME B31.5 ASME 31.9 ASTM F708 MSS SP 58 MSS SP 69 MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.
- G. Support vertical piping at every other floor. Support vertical cast iron pipe at each floor at hub.
- H. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- I. Support riser piping independently of connected horizontal piping.
- J. Provide copper plated hangers and supports for copper piping sheet lead packing between hangers or support and piping.
- K. Design hangers for pipe movement without disengagement of supported pipe.
- L. Prime coat exposed steel hangers and supports. Refer to Section 09 90 00. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation. Refer to Section 22 07 00.

3.5 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment Refer to Section 03 30 00.
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
- C. Construct supports of steel members formed steel channel steel pipe and fittings Brace and fasten with flanges bolted to structure.

- D. Provide rigid anchors for pipes after vibration isolation components are installed. Refer to Section 22 05 48.

### 3.6 INSTALLATION - FLASHING

- A. Provide flexible flashing and metal counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.
- B. Flash vent and soil pipes projecting 3 inches minimum above finished roof surface with lead worked 1 inch minimum into hub, 8 inches minimum clear on sides with 24 x 24 inches sheet size. For pipes through outside walls, turn flanges back into wall and caulk, metal counter-flash, and seal.
- C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides with minimum 36 x 36 inch sheet size. Fasten flashing to drain clamp device.
- D. Seal floor, shower, mop sink drains watertight to adjacent materials.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

### 3.7 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Install chrome plated steel or stainless steel escutcheons at finished surfaces.

### 3.8 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping. Refer to Section 07 84 13

3.9 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect installed firestopping for compliance with specifications and submitted schedule.

3.10 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Clean adjacent surfaces of firestopping materials.

3.11 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

3.12 SCHEDULES

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING Feet	HANGER ROD DIAMETER Inches
Cast Iron (All Sizes)	5	5/8
Cast Iron (All Sizes) with 10 foot length of pipe	10	5/8
Copper Tube, 1-1/4 inches and smaller	6	1/2
Copper Tube, 1-1/2 inches and larger	10	1/2
Polybutylene	2.67	3/8
Polypropylene	4	3/8
PVC (All Sizes)	4	3/8
Steel, 3 inches and smaller	12	1/2
Steel, 4 inches and larger	12	5/8

END OF SECTION 220529

SECTION 220548 VIBRATION CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 INTENT

- A. All plumbing equipment and piping as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
- B. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
- C. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.

1.2 SUMMARY

- A. Related Sections:
  - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  - 2. Section 22 04 00 – General Conditions for Plumbing Trades
  - 3. Section 22 05 00 – Common Work Results for Plumbing.
  - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  - 5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
  - 6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
  - 7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
  - 8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  - 9. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  - 10. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  - 11. Section 22 07 00 – Plumbing Insulation.
  - 12. Section 22 11 23 – Facility Natural-Gas Piping.
  - 13. Section 22 21 23 – Plumbing Pumps.
  - 14. Section 22 40 00 – Plumbing Fixtures
  - 15. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.3 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI S1.4 - Sound Level Meters.
  - 2. ANSI S1.8 - Reference Quantities for Acoustical Levels.
  - 3. ANSI S12.36 - Survey Methods for the Determination of Sound Power Levels of Noise Sources.

- B. Air-Conditioning and Refrigeration Institute:
  - 1. ARI 575 - Method of Measuring Machinery Sound within Equipment Space.
- C. American Society of Heating, Refrigerating and:
  - 1. ASHRAE Handbook - HVAC Applications.

#### 1.4 RELATED WORK

- A. Housekeeping Pads
  - 1. Housekeeping pad reinforcement and monolithic pad attachment to the structure details and design shall be prepared by the restraint vendor if not already indicated on the drawings.
  - 2. Housekeeping pads shall be coordinated with restraint vendor and sized to provide a minimum edge distance of ten (10) bolt diameters all around the outermost anchor bolt to allow development of full drill-in wedge anchor ratings. If cast-in anchors are to be used, the housekeeping pads shall be sized to accommodate the ACI requirements for bolt coverage and embedment.
- B. Supplementary Support Steel
  - 1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.
- C. Attachments
  - 1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. Provide vibration isolation on motor driven equipment over 0.5 hp, plus connected piping.
- B. Provide minimum static deflection of isolators for equipment as follows:
  - 1. Basement, Under 20 hp
    - a. 400 - 600 rpm: 1 inch
    - b. 600 - 800 rpm: 0.5 inch
    - c. 800 - 900 rpm: 0.2 inch
    - d. 1100 - 1500 rpm: 0.14 inch
    - e. Over 1500 rpm: 0.1 inch
  - 2. Basement, Over 20 hp
    - a. 400 - 600 rpm: 2 inch
    - b. 600 - 800 rpm: 1 inch
    - c. 800 - 900 rpm: 0.5 inch
    - d. 1100 - 1500 rpm: 0.2 inch
    - e. Over 1500 rpm: 0.15 inch
- C. Maintain sound level of spaces at levels not to exceed those listed below by utilizing acoustical devices.

- D. Maintain rooms at following maximum sound levels, in Noise Criteria (NC) Room Criteria (RC) as defined by ASHRAE Handbook., HVAC Applications, ANSI S1.8.
  - 1. Offices
    - a. Executive: 30
    - b. Conference rooms: 30
    - c. Private: 35
    - d. Open-plan areas: 40
    - e. Computer/business machine areas: 45
    - f. Public circulation: 45
  - 2.

## 1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings:
  - 1. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
  - 2. Provide Drawings showing methods of suspension and support guides for conduit, piping and ceiling hung equipment.
  - 3. Record actual locations and installation of vibration isolators including attachment points.
  - 4. Drawings showing methods for isolation of conduits and pipes penetrating walls and floor slabs.
  - 5. Specific details of restraints including anchor bolts for mounting and maximum loading at each location, for each piece of equipment and/or pipe locations.
- C. Product Data: Submit schedule of vibration isolator type with location and load on each. Submit catalog information indicating, materials, dimensional data, pressure losses, and acoustical performance for standard sound attenuation products.
- D. Design Data: Submit calculations indicating maximum room sound levels are not exceeded. Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as express in Table 34 of Chapter 47, "Sound and Vibration Control" of the 2015 ASHRAE Handbook – HVAC Applications, shall be used.
- E. Test Reports: Indicate dynamic insertion loss and noise generation values of silencers. Acoustic housings meet or exceed specified sound transmission loss values.
- F. Manufacturer's Installation Instructions: Submit special procedures and setting dimensions. Indicate installation requirements maintaining integrity of sound isolation.
- G. Manufacturer's Certificate: Certify isolators meet or exceed specified requirements.
- H. Manufacturer's Field Reports: Indicate sound isolation installation is complete and in accordance with instructions.

1.7 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of hangers including attachment points.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with ARI 575 ANSI S12.36.
- B. Maintain one copy of each document on site.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.10 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.12 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall have the following responsibilities:
  1. Determine vibration isolation sizes and locations per specifications.
  2. Provide and install isolation systems as scheduled or specified.
  3. Guarantee specified isolation system deflection.
  4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
  5. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.
  6. Substitution of "Internally Isolated" mechanical equipment in lieu of the specified isolation of this section is acceptable

1.13 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.



## PART 2 PRODUCTS

### 2.1 VIBRATION ISOLATORS

- A. Manufacturers:
  - 1. Mason
  - 2. Vibration Eliminator
  - 3. Amber Booth
  
- B. Open Spring Isolators:
  - 1. Spring Isolators:
    - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
    - b. Code: Color code springs for load carrying capacity.
  - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
  - 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
  
- C. Restrained Spring Isolators:
  - 1. Spring Isolators:
    - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
    - b. Code: Color code springs for load carrying capacity.
  - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - 3. Spring Mounts: Furnish with leveling devices, minimum 0.25 inch thick neoprene sound pads, and zinc chromate plated hardware.
  - 4. Sound Pads: Size for minimum deflection of 0.05 inch; meet requirements for neoprene pad isolators.
  - 5. Restraint: Furnish mounting frame and limit stops.
  
- D. Closed Spring Isolators:
  - 1. Spring Isolators:
    - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
    - b. Code: Color code springs for load carrying capacity.
  - 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
  - 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance.

- E. Restrained Closed Spring Isolators:
  - 1. Spring Isolators:
    - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
    - b. Code: Color code springs for load carrying capacity.
  - 2. Type: Closed spring mount with top and bottom housing separated with neoprene rubber stabilizers.
  - 3. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - 4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators, and neoprene side stabilizers with minimum 0.25 inch clearance and limit stops.
  
- F. Spring Hanger:
  - 1. Spring Isolators:
    - a. For Exterior and Humid Areas: Furnish hot dipped galvanized housings and neoprene coated springs.
    - b. Code: Color code springs for load carrying capacity.
  - 2. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 0.3 and 0.6 of maximum deflection.
  - 3. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators rubber hanger with threaded insert.
  - 4. Misalignment: Capable of 20 degree hanger rod misalignment.
  
- G. Neoprene Pad Isolators:
  - 1. Rubber or neoprene-waffle pads.
    - a. 30 durometer.
    - b. Minimum 1/2 inch thick.
    - c. Maximum loading 40 psi.
    - d. Height of ribs: not to exceed 0.7 times width.
  - 2. Configuration: Single layer.
  
- H. Rubber Mount or Hanger: Molded rubber designed for 0.5 inches deflection with threaded insert.
  
- I. Glass Fiber Pads: Neoprene jacketed pre-compressed molded glass fiber.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
  
- B. Verify equipment and piping is installed before work in this section is started.

3.2 INSTALLATION

- A. Install isolation for motor driven equipment.
- B. Adjust equipment level.
- C. Install spring hangers without binding.
- D. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.
- E. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height. When full load is applied, adjust isolators to load to allow shim removal.
- F. Provide pairs of horizontal limit springs on fans with more than 6.0 inch static pressure, and on hanger supported, horizontally mounted axial fans.
- G. Support piping connections to isolated equipment resiliently to nearest flexible pipe connector. as follows:
  - 1. Up to 4 inch Diameter: First three points of support.
  - 2. 5 to 8 inch Diameter: First four points of support.
  - 3. 10 inch Diameter and Over: First six points of support.
  - 4. Select three hangers closest to vibration source for minimum 1.0 inch static deflection or static deflection of isolated equipment. Select remaining isolators for minimum 1.0 inch static deflection or 1/2 static deflection of isolated equipment.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect isolated equipment after installation and submit report. Include static deflections.
- C. After start-up, final corrections and balancing of systems take octave band sound measurements over full audio frequency range in areas adjacent to plumbing equipment rooms, duct and pipe shafts, and other critical locations. Provide one-third octave band measurements of artificial sound sources in areas indicated as having critical requirements. Submit complete report of test results including sound curves.
- D. Furnish services of testing agency to take noise measurement. Use meters meeting requirements of ANSI S1.4.

3.4 SCHEDULES

A. Pipe Isolation Schedule:

Pipe Size Inch	Isolated Distance from Equipment
1	120 diameters
2	90 diameters
3	80 diameters
4	75 diameters

3.5 VIBRATION ISOLATION INSTALLATION

- A. Horizontal pipe isolation: The first three pipe hangers in the main lines near the mechanical equipment shall be as described in specification 11. Specification 11 hangers must also be used in all transverse braced isolated locations. Brace hanger rods with SRC clamps specification 14. Horizontal runs in all other locations throughout the building shall be isolated by hangers as described in specification 10. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical. Where piping connects to mechanical equipment install specification 23 expansion joints or specification 24 stainless hoses if 23 is not suitable for the service.
- B. Riser isolation: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to  $\pm 25\%$  of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.
- C. Vibration Isolation of Plumbing Equipment
1. All equipment shall be vibration restrained as per the schedules in part 3.5 of this specification.
  2. Equipment mounted on housekeeping pads: Pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
  3. Requirements for installation on concrete inertia bases shall be as follows:
    - a. Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".

- b. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.
- c. The isolators shall be installed without raising the machine and frame assembly.
- d. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.
- e. Install equipment with flexibility in wiring connection.
- f. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".
- g. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base.

### 3.6 INSPECTION

- A. Examine systems under provisions of Division 1.
- B. On completion of installation of all vibration isolation devices herein specified, the manufacturer's representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION 220548

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SECTION 220553 IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Nameplates.
  - 2. Tags.
  - 3. Pipe markers.
  - 4. Ceiling tacks.
  - 5. Labels.
  - 6. Lockout devices.
  
- B. Related Sections:
  - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  - 2. Section 22 04 00 – General Conditions for Plumbing Trades
  - 3. Section 22 05 00 – Common Work Results for Plumbing.
  - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  - 5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
  - 6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
  - 7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
  - 8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  - 9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
  - 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  - 11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  - 12. Section 22 07 00 – Plumbing Insulation.
  - 13. Section 22 11 23 – Facility Natural-Gas Piping.
  - 14. Section 22 21 23 – Plumbing Pumps.
  - 15. Section 22 40 00 – Plumbing Fixtures
  - 16. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME A13.1 - Scheme for the Identification of Piping Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Product Data: Submit manufacturers catalog literature for each product required.

- C. Shop Drawings: Submit list of wording, symbols, letter size, and color coding for mechanical identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
  - D. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.
  - E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.4 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Project Record Documents: Record actual locations of tagged valves; include valve tag numbers.
- 1.5 QUALITY ASSURANCE
- A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.
  - B. Conform to ASME A13.1 for color scheme for identification of piping systems and accessories.
  - C. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
  - B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.8 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.



1.9 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two containers of spray-on adhesive

1.10 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
  - 1. Craftmark Identification Systems
  - 2. Safety Sign Co.
  - 3. Seton Identification Products
- B. Product Description: Laminated three-layer plastic with engraved black letters on light contrasting background color.

2.2 TAGS

- A. Metal Tags:
  - 1. Manufacturers:
    - a. Craftmark Identification Systems
    - b. Safety Sign Co.
    - c. Seton Identification Products
  - 2. Stainless Steel with stamped letters; tag size minimum 1-1/2 inches diameter with finished edges.
- B. Information Tags:
  - 1. Manufacturers:
    - a. Craftmark Identification Systems
    - b. Safety Sign Co.
    - c. Seton Identification Products
  - 2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches with grommet and self-locking nylon ties.
- C. Tag Chart: Typewritten letter size list of applied tags and location plastic laminated.

## 2.3 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
  - 1. Manufacturers:
    - a. Craftmark Identification Systems
    - b. Safety Sign Co.
    - c. Seton Identification Products
    - d. Substitutions: Section 01 60 00 - Product Requirements.
  - 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Tape Pipe Markers:
  - 1. Manufacturers:
    - a. Craftmark Identification Systems
    - b. Safety Sign Co.
    - c. Seton Identification Products
  - 2. Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Plastic Underground Pipe Markers:
  - 1. Manufacturers:
    - a. Seton
    - b. Northtown
    - c. Kolbi
  - 2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.

## 2.4 CEILING TACKS

- A. Manufacturers:
  - 1. Seton
  - 2. Northtown
  - 3. Kolbi
- B. Description: Steel with 3/4 inch diameter color-coded head.
- C. Color code as follows:
  - 1. Plumbing valves: Green.

## 2.5 LABELS

- A. Manufacturers:
  - 1. Seton
  - 2. Northtown
  - 3. Kolbi

- B. Description: Aluminum, size 1.9 x 0.75 inches, adhesive backed with printed identification and bar code.

## 2.6 LOCKOUT DEVICES

- A. Lockout Hasps:
  - 1. Manufacturers:
    - a. Seton
    - b. Brady
    - c. Omark
  - 2. Reinforced nylon hasp with erasable label surface; size minimum 7-1/4 x 3 inches.
- B. Valve Lockout Devices:
  - 1. Manufacturers:
    - a. Seton
    - b. Brady
    - c. Omark
  - 2. Nylon device preventing access to valve operator, accepting lock shackle.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 90 00 for stencil painting.

### 3.2 INSTALLATION

- A. Install identifying devices after completion of coverings and painting.
- B. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive.
- C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- D. Install tags using corrosion resistant chain. Number tags consecutively by location.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Identify water heaters, pumps, tanks, and water treatment devices with plastic nameplates stencil painting. Identify in-line pumps and other small devices with tags.
- G. Identify control panels and major control components outside panels with plastic nameplates.

- H. Identify valves in main and branch piping with tags.
- I. Identify piping, concealed or exposed, with plastic pipe markers plastic tape pipe markers stenciled painting. Use tags on piping 3/4 inch diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- J. Provide ceiling tacks to locate valves above T-bar type panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION 220553

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SECTION 220700 PLUMBING INSULATION

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Plumbing piping insulation, jackets and accessories.
  2. Plumbing equipment insulation, jackets and accessories.
- B. Related Sections:
1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  2. Section 22 04 00 – General Conditions for Plumbing Trades
  3. Section 22 05 00 – Common Work Results for Plumbing.
  4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  5. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  6. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  7. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  8. Section 22 21 23 – Plumbing Pumps.
  9. Section 22 40 00 – Plumbing Fixtures
  10. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

- A. ASTM International:
1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
  2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
  3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
  5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
  6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
  7. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
  8. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
  9. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
  10. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

11. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
12. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
13. ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.
14. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
15. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.
16. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
17. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
18. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
19. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
20. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
21. IECC 2012 – Insulation Thickness.

### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

### 1.4 QUALITY ASSURANCE

- A. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 450 50 in accordance with ASTM E84.
- B. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- C. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- D. Maintain one copy copies of each document on site.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.
- B. Furnish five year manufacturer warranty for man made fiber.

## PART 2 PRODUCTS

### 2.1 MANUFACTURER

- A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
  - 1. CertainTeed.
  - 2. Knauf.
  - 3. Johns Manville.
  - 4. Owens-Corning.
  
- B. Manufacturers for Closed Cell Elastomeric Insulation Products:
  - 1. Aeroflex. Aerocell.
  - 2. Armacell, LLC. Armaflex.
  - 3. Nomaco. K-flex.

### 2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation. Conform to ASTM C795 for application on Austenitic stainless steel.
  - 1. Thermal Conductivity: 0.23 at 75 degrees F.
  - 2. Operating Temperature Range: 0 to 850 degrees F.
  - 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
  - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
  
- B. TYPE P-5: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
  - 1. Thermal Conductivity: 0.27 at 75 degrees F.
  - 2. Operating Temperature Range: Range: Minus 70 to 180 degrees F.

### 2.3 PIPE INSULATION JACKETS

- A. Vapor Retarder Jacket:
  - 1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
  - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
  
- B. PVC Plastic Pipe Jacket:
  - 1. Product Description: ASTM D1785, One piece molded type fitting covers and sheet material, off-white color.
  - 2. Thickness: 15 mil.
  - 3. Connections: Brush on welding adhesive Tacks Pressure sensitive color matching vinyl tape.

### 2.4 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
  
- B. Covering Adhesive Mastic: Compatible with insulation.



- C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.
- E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum stainless steel jacket single piece construction with self adhesive closure. Thickness to match pipe insulation.
- F. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- G. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
- H. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- I. Adhesives: Compatible with insulation.

## 2.5 EQUIPMENT INSULATION

- A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
  - 1. Thermal Conductivity: 0.24 at 75 degrees F.
  - 2. Operating Temperature Range: 0 to 450 degrees F.
  - 3. Density: 1.65 pound per cubic foot.
- B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied kraft reinforced aluminum foil jacket.
  - 1. Thermal Conductivity: 0.24 at 75 degrees F.
  - 2. Operating Temperature Range: 0 to 450 degrees F.
  - 3. Density: 3.0 pound per cubic foot.
  - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- C. TYPE E-8: ASTM C534, Type II, flexible, closed cell elastomeric insulation, sheet.
  - 1. Thermal Conductivity: 0.27 at 75 degrees F.
  - 2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.
  - 3. .

## 2.6 EQUIPMENT INSULATION JACKETS

- A. PVC Plastic Equipment Jacket:
  - 1. Product Description: ASTM D1785, sheet material, off-white color.
  - 2. Minimum Service Temperature: -40 degrees F.
  - 3. Maximum Service Temperature: 150 degrees F.
  - 4. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
  - 5. Thickness: 20 mil.
  - 6. Connections: Brush on welding adhesive Tacks Pressure sensitive color matching vinyl tape.

- B. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.
  - C. Vapor Retarder Jacket:
    - 1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
    - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
  - D. Field Applied Glass Fiber Fabric Jacket System:
    - 1. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
    - 2. Glass Fiber Fabric:
      - a. Cloth: Untreated; 9 oz/sq yd weight.
      - b. Blanket: 1.0 lb/cu ft density.
      - c. Weave: 10 x 10.
    - 3. Indoor Vapor Retarder Finish:
      - a. Cloth: Untreated; 9 oz/sq yd weight.
      - b. Vinyl emulsion type acrylic, compatible with insulation, black white color.
- 2.7 EQUIPMENT INSULATION ACCESSORIES
- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
  - B. Covering Adhesive Mastic: Compatible with insulation.
  - C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
  - D. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449/C449M.
  - E. Adhesives: Compatible with insulation.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping and equipment has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

### 3.2 INSTALLATION - PIPING SYSTEMS

- A. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
- B. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when

continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 07 84 00 for penetrations of assemblies with fire resistance rating greater than one hour.

- C. Piping Systems Conveying Fluids Below Ambient Temperature:
  - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
  - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
  - 3. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.
  
- D. Glass Fiber Board Insulation:
  - 1. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
  - 2. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
  - 3. Cover wire mesh or bands with cement to a thickness to remove surface irregularities.
  
- E. Hot Piping Systems less than 140 degrees F:
  - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
  - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
  - 3. Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.
  
- F. Hot Piping Systems greater than 140 degrees F:
  - 1. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
  - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
  - 3. Insulate flanges and unions at equipment.
  
- G. Inserts and Shields:
  - 1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
  - 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
    - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.

- b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
  - 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.
  
- H. Insulation Terminating Points:
  - 1. Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.
  - 2. Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.
  - 3. Condensate Piping: Insulate entire piping system and components to prevent condensation.
  
- I. Closed Cell Elastomeric Insulation:
  - 1. Push insulation on to piping.
  - 2. Miter joints at elbows.
  - 3. Seal seams and butt joints with manufacturer's recommended adhesive.
  - 4. When application requires multiple layers, apply with joints staggered.
  - 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
  
- J. High Temperature Pipe Insulation:
  - 1. Install in multiple layers to meet thickness scheduled.
  - 2. Attach each layer with bands. Secure first layer with bands before installing next layer.
  - 3. Stagger joints between layers.
  - 4. Finish with canvas jacket sized for finish painting.
  - 5. Cover with aluminum jacket stainless steel jacket with seams located on bottom side of horizontal piping.
  
- K. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting PVC jacket and fitting covers ABS jacket and fitting covers aluminum jacket stainless steel jacket.
  
- L. Piping Exterior to Building: Provide vapor retarder jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with aluminum stainless steel jacket with seams located at 3 or 9 o'clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.
  
- M. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.

3.3 INSTALLATION - EQUIPMENT

- A. Factory Insulated Equipment: Do not insulate.
- B. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- C. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
- D. Equipment Containing Fluids Below Ambient Temperature:
  - 1. Insulate entire equipment surfaces.
  - 2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
  - 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
  - 4. Finish insulation at supports, protrusions, and interruptions.
- E. Equipment Containing Fluids 140 degrees F Or Less:
  - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
  - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
  - 3. Finish insulation at supports, protrusions, and interruptions.
- F. Equipment Containing Fluids Over 140 degrees F:
  - 1. Insulate flanges and unions with removable sections and jackets.
  - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
  - 3. Finish insulation at supports, protrusions, and interruptions.
- G. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with PVC jacket.
- H. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with aluminum stainless steel jacket with seams located on bottom side of horizontal equipment.
- I. Cover glass fiber cellular glass hydrous calcium silicate cellular foam insulation with metal mesh and finish with heavy coat of insulating cement aluminum jacket stainless steel jacket.
- J. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
- K. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

L. Prepare equipment insulation for finish painting. Refer to Section 09 90 00.

3.4 SCHEDULES

A. Water Supply Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Domestic Hot Water Supply and Recirculation	P-1	1-1/4 inches and smaller	0.5
		1-1/2 inches and larger	1.0
Domestic Cold Water	P-1 or P-5	1-1/4 inches and smaller	0.5
		1-1/2 inches and larger	1.0

B. Drainage Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Storm Piping (above ground within building)	P-1 or P-5	All sizes	1.0
Storm Piping (horizontal and vertical above ground within building when PVC pipe is used)	P-1 or P-5	All sizes	1.0
Sanitary Sewer Piping (horizontal and vertical above ground within building when PVC or plastic piping is used)	P-1 or P-5	All sizes	1.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Roof Drain Bodies	E-2, E-8	0.5
Domestic Hot Water Storage Tanks	E-2	1.5

END OF SECTION 220700

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## SECTION 222123 PLUMBING PUMPS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. In-line circulators.
  
- B. Related Sections:
  - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  - 2. Section 22 04 00 – General Conditions for Plumbing Trades
  - 3. Section 22 05 00 – Common Work Results for Plumbing.
  - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  - 5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
  - 6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
  - 7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
  - 8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  - 9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
  - 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  - 11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  - 12. Section 22 07 00 – Plumbing Insulation.
  - 13. Section 22 11 23 – Facility Natural-Gas Piping.
  - 14. Section 22 21 23 – Plumbing Pumps.
  - 15. Section 22 40 00 – Plumbing Fixtures
  - 16. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  
- B. Underwriters Laboratories Inc.:
  - 1. UL 778 - Motor Operated Water Pumps.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Provide pumps to operate at system fluid temperatures indicated on Drawings without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.
- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
- C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.
- B. Furnish one set of mechanical seals for each pump.

PART 2 PRODUCTS

2.1 IN-LINE CIRCULATORS

- A. Manufacturers:
  - 1. B+G
  - 2. Taco
  - 3. Armstrong
  - 4. Grundfos
- B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psig 175 psig maximum working pressure.
- C. Casing: Cast iron, with flanged pump connections.
- D. Impeller: Cadmium plated steel, Stamped brass or cast bronze, keyed to shaft.
- E. Bearings: Two, oil lubricated bronze sleeves.
- F. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.
- G. Seal: Carbon rotating against stationary ceramic seat, 225 212 degrees F maximum continuous operating temperature.
- H. Drive: Flexible coupling.
- I. Electrical Characteristics and Components:
  - 1. Motors: In accordance with Section 23 05 13. 1750 rpm unless indicated otherwise.
  - 2. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge line sizes 4 inches and over.
- C. Install pumps on vibration isolators. Refer to Section 22 05 48.
- D. Install flexible connectors at or near pumps where piping configuration does not absorb vibration. On Victaulic grooved installations, install three (3) Flexible couplings in lieu of each flexible connector and place in close proximity to the vibrating source. Refer to Section 23 05 48.
- E. Provide line sized shut-off valve and strainer pump suction fitting on pump suction, and line sized soft seat check valve, balancing valve, and shut-off valve combination pump discharge valve on pump discharge. On Victaulic grooved installations, provide line sized combination Tri-Service Assembly or AGS Tri-Service Assembly with grooved ends. Refer to Section Section 22 05 23
- F. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump so no weight is carried on pump casings. Provide supports under elbows on pump suction and discharge line sizes 4 inches and larger.
- G. Provide air cock and drain connection on horizontal pump casings.
- H. Provide drains for bases and seals.
- I. Check, align, and certify alignment of base mounted pumps prior to start-up.
- J. Install close coupled and base mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 03 30 00.
- K. Lubricate pumps before start-up.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

END SECTION 222123

SECTION 223000 PLUMBING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Floor drains.
2. Floor sinks
3. Area drains.
4. Cleanouts.
5. Hose bibs.
6. Wall hydrants.
7. Water hammer arrestors.
8. Trap primers.
9. Water meters.
10. Expansion tanks.
11. Recessed valve boxes.
12. Stops.

B. Related Sections:

1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 00 – Common Work Results for Plumbing.
4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
12. Section 22 07 00 – Plumbing Insulation.
13. Section 22 11 23 – Facility Gas Piping.
14. Section 22 21 23 – Plumbing Pumps.
15. Section 22 34 00 – Domestic Water Heaters.
16. Section 22 40 00 – Plumbing Fixtures
17. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

## 1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI/ASSE 1011 - Hose Connection Vacuum Breakers.
  - 2. ANSI/ASSE 1019 - Wall Hydrants, Frost Proof Automatic Draining Anti-Backflow Types.
  - 3. ANSI A112.21.1 - Floor Drains.
  - 4. ANSI A112.21.2 - Roof Drains.
  - 5. ANSI A112.26.1 - Water Hammer Arrestors.
- B. International Association of Plumbing and Mechanical Officials:
  - 1. IAPMO IGC 187 – Roof Drains with Integral Overflow Drain.
- C. Plumbing Drainage institute:
  - 1. PDI WH-201 – Water Hammer Arresters.
- D. Safe Drinking Water Act.
  - 1. SDWA 1417 - Standard for Lead Free Drinking Water.

## 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate dimensions, weights, and placement of openings and holes.
- C. Product Data: Provide component sizes, rough-in requirements, service sizes, capacities and finishes.
- D. Manufacturer's Installation Instructions: Submit installation methods and procedures. Indicate assembly and support requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

## 1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.

## 1.5 QUALITY ASSURANCE

- A. Record actual locations of equipment, cleanouts, etc.
- B. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc. as suitable for purpose specified and indicated.

- C. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.
  - D. All plumbing specialties installed on the domestic water distribution system including hose bibs, wall hydrants, meters, valves and stops shall be lead free and shall meet the requirements of SDWA 1417.
  - E. Maintain one copy of each document on site.
  - F. Alternate Roof Drainage System:
    - 1. Basis of design for this project is roof drains with integral overflow drain. If contractor elects to provide roof drains and non-integral overflow drains, overflow drains must be installed so as not to allow the overflow drain to flow prematurely nor allow excessive loading of overflow water. This installation shall conform to all governing local and state codes.
    - 2. Roof drain manufacturer shall provide documentation certifying the proper location and placement of primary and overflow drains to assure proper operation of the system.
    - 3. Installation of two-drain system shall be warranted by the installing contractor in regards to the correct lateral and vertical placement of the overflow drain to prevent premature flow to the overflow system.
  - G. Alternate roof drainage system, if used must include all costs of all involved trades and fees for additional design work associated with installation.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
  - B. Installer: Company specializing in performing work of this section with minimum three years documented experience.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
  - B. Accept specialties on site in factory packaging. Inspect for damage.
  - C. Protect installed specialties from damage by securing areas.

1.9 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Requirements for warranties.
- B. : Product warranties and product bonds.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Provide two loose keys for hose bibs and wall hydrants

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
  - 1. JR Smith.
  - 2. Watts.
  - 3. Josam.
  - 4. Wade.
  - 5. Zurn.
  - 6. MiFab.

2.2 FLOOR DRAINS

- A. Floor Drains: ANSI A112.21.1, cast iron body, nickel bronze top, flashing collar, adjustable strainer-head, trap primer connection.

2.3 FLOOR SINKS

- A. Floor Sinks: ANSI A112.21.1. Square nickel bronze top, dome bottom strainer, flashing collar, trap primer connection.

2.4 AREA DRAINS

- A. Area Drains: ANSI A112.21.2.

2.5 CLEANOUTS

- A. Interior Finished Floor Cleanouts: Cast iron body with adjustable scoriated nickel bronze top and vandal proof screws.
- B. Interior Finished Wall Cleanouts: Line type with cast iron body, round epoxy coated gasketed cover and round stainless steel access cover secured with machine screw.
- C. Interior Unfinished Accessible Areas: Caulked or threaded type. Provide stack cleanouts on vertical rainwater leaders.



2.6 HOSE BIBS

- A. Manufacturers:
  - 1. Woodford.
  - 2. Josam.
  - 3. Wade.
  - 4. Zurn.
  - 5. Watts.
- B. ANSI/ASSE 1011 Bronze or brass with integral mounting flange, lead free.

2.7 WALL HYDRANTS

- A. Manufacturers:
  - 1. Woodford.
  - 2. Josam.
  - 3. Wade.
  - 4. Zurn.
  - 5. Watts.
- B. Wall Hydrant: ANSI/ASSE 1019; self-draining type, lead free, backflow protected, freeze proof with removable key.

2.8 WATER HAMMER ARRESTORS

- A. Manufacturers:
  - 1. Woodford.
  - 2. Josam.
  - 3. Wade.
  - 4. Zurn.
  - 5. Watts.
- B. ANSI A112.26.1; sized in accordance with PDI, lead free precharged, suitable for operation in temperature range -100 to 300 degrees F (-73 to 149 degrees C) and maximum 250 psig (1700 kPa) working pressure.

2.9 TRAP PRIMERS

- A. Manufacturers:
  - 1. Woodford.
  - 2. Josam.
  - 3. Wade.
  - 4. Zurn.
  - 5. Watts.
  - 6. PPP.
- B. ASSE 1018: Corrosion resistant brass, lead free, temperature range -40 to 450 degrees, ½" male inlet and ½" female outlet, pressure operating range 35 to 75 psig.

2.10 EXPANSION TANKS

- A. Manufacturers:
  - 1. Amtrol.
  - 2. Taco.
  - 3. Bell and Gossett.
  - 4. Watts.
- B. Construction: Welded steel, ASME labeled, tested and stamped in accordance with Section 8D of ASME Code; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with flexible EPDM diaphragm sealed into tank, and steel legs or saddles.

2.11 RECESSED VALVE BOXES

- A. Manufacturers: Symmons model as scheduled on the drawings.
- B. Other acceptable manufacturers offer equivalent products:
  - 1. Acorn
  - 2. Josam
  - 3. Potter Roemer
- C. Washing Machine: Plastic preformed rough-in box with brass water control valve, socket for 2 inch waste, and cover.
- D. Refrigerator: Plastic preformed rough-in box with brass valves with wheel handle, slip in finishing cover.

2.12 STOPS

- A. Manufacturers:
  - 1. Brass Craft.
  - 2. Watts.
  - 3. Nibco.
  - 4. McGuire.
- B. Chrome plated angle brass supply stop valve with full turn brass stem, lead free, inlet shall be 1/2-inch sweat, outlet shall be 3/8-inch compression. Supply stop shall be LFST082LK as manufactured by McGuire or approved equal.

2.13 WATER METERS CONNECTED TO BMS (M-1, M-2 and M-3)

- A. Manufacturers:
  - 1. Onicon F-1000 Series.
  - 2. Neptune.
  - 3. Omega.
- B. In-line, turbine type approved for potable water. Accuracy shall be 1.0% at 3 to 30 feet per second flow rate.

- C. Provide with 24VAC power connections and pulse output signal compatible with Building Management System (BMS)

#### 2.14 WATER METERS WITH VISUAL READOUT (M-4)

- A. Manufacturers:
  - 1. Badger.
  - 2. Neptune.
  - 3. Pulsafeeder.
  - 4. Onicon.
  - 5. Omegae.
- B. In-line, bronze construction approved for potable water. Accuracy shall be 1.5% at 3 to 30 feet per second flow rate. Provide with visual readout totalizing water usage..

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify walls and floor finishes are prepared and ready for installation of fixtures.
- C. Verify electric power is available and of correct characteristics.

#### 3.2 PREPARATION

- A. Coordinate cutting and forming of roof and floor construction to receive drains to required invert elevations.

#### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Cleanouts shall be same size as the pipes served, up to 4 inches; 5 and 6 inch pipes shall have 4 inch cleanouts; 8 inch pipes shall have 6 inch cleanouts; 10 inch pipes and larger shall have 8 inch cleanouts.
- D. Install components level and plumb.
- E. Install water hammer arrestors with isolation valve in accessible locations.
- F. Trap primers shall be installed to serve all floor drains, provide distribution units as required for all drains.

- G. Trap primer connections shall be installed on cold water piping 1 ½ inch diameter or less.
  - H. Install hose bib with integral vacuum breaker and with cold water supply in all gang toilet rooms.
- 3.4 INTERFACE WITH OTHER PRODUCTS
- A. Review millwork shop-drawings. Confirm location and size of drains before rough in and installation.
- 3.5 ADJUSTING
- A. Section 01 77 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- 3.6 CLEANING
- A. Section 01 77 00 - Execution and Closeout Requirements: Final cleaning.
- 3.7 PROTECTION OF INSTALLED CONSTRUCTION
- A. Section 01 77 00 - Execution and Closeout Requirements: Protecting installed construction.

END OF SECTION 223000

SECTION 223402 DOMESTIC WATER HEATERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Commercial water heaters.
  
- B. Related Sections:
  - 1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
  - 2. Section 22 04 00 – General Conditions for Plumbing Trades
  - 3. Section 22 05 00 – Common Work Results for Plumbing.
  - 4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
  - 5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
  - 6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
  - 7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
  - 8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
  - 9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
  - 10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
  - 11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
  - 12. Section 22 07 00 – Plumbing Insulation.
  - 13. Section 22 21 23 – Plumbing Pumps.
  - 14. Section 22 40 00 – Plumbing Fixtures
  - 15. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

1.2 REFERENCES

- A. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
  
- B. American Society of Mechanical Engineers:
  - 1. ASME PTC 25 - Pressure Relief Devices.
  - 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.
  
- C. United States Department of Energy:
  - 1. DOE 10 CFR - Uniform Test Method for Measuring the Energy Consumption of Furnaces.
  
- D. ICC
  - 1. IECC.
  - 2. IFGC

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.
- C. Product Data:
  - 1. Water Heaters: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements. Submit electrical characteristics and connection locations.
- D. Manufacturer's Installation Instructions: Submit mounting and support requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.5 QUALITY ASSURANCE

- A. ASME Compliance: Water Heater shall bear ASME HLW stamp and be National Board listed.
- B. The water heater will comply shall current ASHRAE 90.1 requirements.
- C. Maintain one copy of each document on site.
- D. Water heater manufacturer certified to the ISO 9001 International Quality System.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience,
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Products storage and handling requirements.
- B. Accept water heaters on site in original labeled cartons. Inspect for damage.
- C. Protect tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 COMMERCIAL WATER HEATERS

- A. Acceptable Manufacturers:
  - 1. HTP
  - 2. AO Smith
  - 3. Lochinvar
  - 4. Bradford White

2.2 COMMERCIAL WATER HEATERS

- A. Tanks shall be 316L stainless steel with Incoloy and stainless steel elements.
- B. To preserve thermal efficiency, the water heater will not use or require a circulator piped from the hot water outlet to the cold water inlet of the heater for the purpose of temperature control during normal operation. Connection for a building return circulation line will be made to a dedicated hot return fitting at the center of the storage vessel and not the cold inlet piping.
- C. Finished vessel will not require sacrificial or impressed current anodes and none will be used. Water heaters or sidearm storage tanks that employ anode rods of any type will not be acceptable.
- D. Provide with drain connection with 3/4" drain with hose end connection.
- E. Provide with T&P Valve.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Maintain manufacturer's recommended clearances around and over water heaters.
- B. Install water heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side. Refer to Section 03 30 00.
- C. Connect domestic hot water domestic cold water piping to supply and return water heater connections.
- D. Install the following piping accessories. Refer to Section 22 11 00.
  - 1. On supply:
    - a. Thermometer well and thermometer.
    - b. Strainer.
    - c. Pressure gage.
    - d. Shutoff valve.
  - 2. On return:
    - a. Thermometer well and thermometer.
    - b. Pressure gage.
    - c. Shutoff valve.
- E. Install discharge piping from relief valves and drain valves to nearest floor drain.
- F. Install circulator and diaphragm expansion tank on water heater.
- G. Install water heater trim and accessories furnished loose for field mounting.
- H. Install electrical devices furnished loose for field mounting.
- I. Install control wiring between water heater control panel and field mounted control devices.

#### 3.2 MANUFACTURER'S FIELD SERVICES

- A. Division 1 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

END OF SECTION 223402



SECTION 223500 DOMESTIC WATER HEAT EXCHANGERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Domestic water heat exchangers.
  - 2. Domestic hot water storage tanks.
  
- B. Related Sections:
  - 1. Section 03 30 00 - Cast-In-Place Concrete: Execution requirements for concrete housekeeping pads specified by this section.
  - 2. Section 22 07 00 - Plumbing Insulation: Field applied insulation for domestic water heaters.
  - 3. Section: 22 11 00 - Facility Water Distribution: Supply connections to domestic water heaters.
  - 4. Section 23 04 00 – General Conditions for Mechanical Trades

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME PTC 25 - Pressure Relief Devices.
  - 2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Shop Drawings: Indicate heat exchanger dimensions, size of taps, and performance data. Indicate dimensions of tanks, tank lining methods, anchors, attachments, lifting points, taps, and drains.
  
- C. Product Data: Submit dimensioned drawings of water heaters indicating components and connections to other equipment and piping. Indicate pump type, capacity and power requirements.
  
- D. Manufacturer's Installation Instructions: Submit mounting and support requirements.
  
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  
- B. Operation and Maintenance Data: Submit replacement part numbers and availability.

1.5 QUALITY ASSURANCE

- A. Conform to ASME Section VIII for construction of heat exchangers. Provide boilers registered with National Board of Boiler and Pressure Vessel Inspectors.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Products storage and handling requirements.
- B. Protect heat exchangers and tanks with temporary inlet and outlet caps. Maintain caps in place until installation.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 DOMESTIC WATER HEAT EXCHANGERS

- A. Manufacturers:
  - 1. HTP.
  - 2. B+G
  - 3. AO Smith.
  - 4. Locinvar.
  - 5. Bradford White.
- B. Tanks: 316L stainless steel with 2" thick foam insulation and metal exterior coated finish.

- C. Tubes: Finned Cupronickel Heat Exchanger. suitable for 125 psi working pressure
- D. Stainless steel cold water and hot water pipe connections.
- E. Stainless steel well for temperature control.
- F. Code: ASME Section VIII for service pressures, ASME "U" symbol stamped on heat exchanger.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Maintain manufacturer's recommended clearances around and over water heaters.
- B. Install heater on concrete housekeeping pad, minimum 3-1/2 inches high and 6 inches larger than water heater base on each side. Refer to Section 03 30 00.
- C. Install the following piping accessories. Refer to Section 22 11 00.
  - 1. On supply:
    - a. Thermometer well and thermometer.
    - b. Strainer.
    - c. Pressure gage.
    - d. Shutoff valve.
  - 2. On return:
    - a. Thermometer well and thermometer.
    - b. Pressure gage.
    - c. Shutoff valve.
- D. Install discharge piping from relief valves and drain valves to nearest floor drain.
- E. Install water heater trim and accessories furnished loose for field mounting.
- F. Install domestic water heat exchangers with clearance for tube bundle removal without disturbing other installed equipment or piping.

#### 3.2 MANUFACTURER'S FIELD SERVICES

- A. Division 1 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

END OF SECTION 223500

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## SECTION 224000 PLUMBING FIXTURES

### PART 1 GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. Water closets.
2. Urinals.
3. Lavatories.
4. Sinks.
5. Service sinks.
6. Electric water coolers.
7. Drinking fountains.
8. Showers.
9. Emergency Eye and Face Wash.
10. Emergency Combination Shower with Eye and Face Wash.

B. Related Sections:

1. Section 07 90 00 - Joint Protection: Product requirements for calking between fixtures and building components for placement by this section.
2. Section 22 04 00 – General Conditions for Plumbing Trades
3. Section 22 05 00 – Common Work Results for Plumbing.
4. Section 22 05 03 – Pipes and Tubes for Plumbing Piping and Equipment.
5. Section 22 05 13 – Common Motor Requirements for Plumbing Equipment
6. Section 22 05 16 – Expansion Fittings and Loops for Plumbing Piping.
7. Section 22 05 23 – General-Duty Valves for Plumbing Piping.
8. Section 22 05 29 – Hangers and Supports for Plumbing Piping and Equipment
9. Section 22 05 48 – Vibration and Seismic Controls for Plumbing Piping and Equipment
10. Section 22 05 53 – Identification for Plumbing Piping and Equipment.
11. Section 22 05 79 – Hangers and Supports for Plumbing Piping and Equipment.
12. Section 22 07 00 – Plumbing Insulation.
13. Section 22 11 23 – Facility Natural-Gas Piping.
14. Section 22 15 00 – General Service Compressed-Air Systems.
15. Section 22 21 23 – Plumbing Pumps.
16. Section 22 34 00 – Fuel-Fired Domestic Water Heaters.
17. Section 22 40 00 – Plumbing Fixtures
18. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections to sensor valves and faucets specified by this section.

#### 1.2 REFERENCES

A. American National Standards Institute:

1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
2. ANSI Z124.2 - Plastic Shower Units.
3. ANSI Z358.1 - Emergency Eyewash and Shower Equipment.

- B. Air-Conditioning and Refrigeration Institute:
    - 1. ARI 1010 - Self-Contained, Mechanically Refrigerated Drinking-Water Coolers.
  - C. American Society of Mechanical Engineers:
    - 1. ASME A112.6.1 - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use.
    - 2. ASME A112.18.1 - Plumbing Fixture Fittings.
    - 3. ASME A112.19.1M - Enameled Cast Iron Plumbing Fixtures.
    - 4. ASME A112.19.2M - Vitreous China Plumbing Fixtures.
    - 5. ASME A112.19.3 - Stainless Steel Plumbing Fixtures (Designed for Residential Use).
    - 6. ASME A112.19.4 - Porcelain Enameled Formed Steel Plumbing Fixtures.
    - 7. ASME A112.19.5 - Trim for Water-Closet Bowls, Tanks and Urinals.
  - D. Safe Drinking Water Act.
    - 1. SDWA 1417 - Standard for Lead Free Drinking Water.
- 1.3 SUBMITTALS
- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  - B. Product Data: Submit catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes. Clearly indicate on submittal "Lead Free" where required.
  - C. Manufacturer's Installation Instructions: Submit installation methods and procedures.
  - D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.4 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Operation and Maintenance Data: Submit fixture, trim, exploded view and replacement parts lists.
- 1.5 QUALITY ASSURANCE
- A. Provide products requiring electrical connections listed and classified by Underwriters Laboratories Inc., testing firm acceptable to authority having jurisdiction as suitable for purpose specified and indicated.
  - B. Provide plumbing fixture fittings in accordance with ASME A112.18.1 that prevent backflow from fixture into water distribution system.
  - C. All plumbing fixtures and associated trim including faucets, valves, stops and water dispensers that are part of the domestic water system shall be lead free in accordance with SDWA 1417. Exclusions include toilets, bidets, urinals, fill valves, flush-o-meter valves, tub fillers, shower valves and main gate valves that are 2-inches and larger.

- D. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
  - B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
  - B. Accept fixtures on site in factory packaging. Inspect for damage.
  - C. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.
- 1.9 WARRANTY
- A. Section 01 78 30 Warranties and Bonds: Product warranties and product bonds.
- 1.10 EXTRA MATERIALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
  - B. Furnish two sets of faucet washers, flush valve service kits, lavatory supply fittings, shower heads and toilet seats.

## PART 2 PRODUCTS

### 2.1 WATER CLOSETS

- A. Manufacturers:
  - 1. American Standard Plumbing
  - 2. Sloan
  - 3. Kohler Co.

2.2 WALL HUNG URINALS

- A. Manufacturers:
  - 1. American Standard Plumbing
  - 2. Sloan
  - 3. Kohler Co.

2.3 LAVATORIES

- A. Lavatory Manufacturers:
  - 1. American Standard
  - 2. Kohler
  - 3. Sloan
- B. Lavatory Faucet Manufacturers:
  - 1. Chicago Faucets
  - 2. Symmons
  - 3. Sloan
- C. Vitreous China Wall Hung Basin: ASME A112.19.2M; vitreous china wall hung lavatory, with 4 inch high back, drillings on 4 inch 8 inch centers, rectangular basin with splash lip, front overflow, and soap depression.
- D. Metered Faucet: ASME A112.18.1, SDWA 1417; chrome plated lead free metered mixing faucet with low voltage battery operated solenoid operator and infrared sensor, gpm aerator spray and cover plate, open grid strainer.
- E. Waste Fittings: ASME A112.18.2 or ASTM F 409.
- F. For public hand washing facilities, provide tempered water through regulating device conforming to ASSE 1070.
- G. Accessories:
  - 1. Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon.
  - 2. Offset waste with perforated open strainer plug and strainer.
  - 3. Lead free Screwdriver stops.
  - 4. Lead free Flexible supplies.
  - 5. Trap and waste insulated and offset to meet ADA compliance.
- H. Wall Mounted Carrier: ASME A112.6.1; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, concealed arm supports, bearing plate and studs.



## 2.4 SINKS

- A. Manufacturers:
  - 1. American Standard Plumbing
  - 2. Eljer Plumbingware
  - 3. Kohler Co.
  - 4. Crane
- B. Single Compartment Bowl: ASME A112.19.3; 18 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch chromed brass drain 3-1/2 inch crumb cup and tailpiece, ledge back drilled for trim.
- C. Double Compartment Bowl: ASME A112.19.3; 18 gage 20 gage thick, Type 304 stainless steel. Self-rimming and undercoated, with 1-1/2 inch chromed brass drains 3-1/2 inch crumb cups and tailpieces, ledge back drilled for trim.
- D. Trim: ASME A112.18.1, SDWA 1417; chrome plated, lead free brass supply with high rise swing spout, vandal proof water economy aerator with maximum 2.2 gpm flow, single lever handle and retractable spray.
- E. Accessories: Chrome plated 17 gage brass P-trap with clean-out plug and arm with escutcheon, lead free wheel handle screwdriver stop, lead free flexible supplies.

## 2.5 SHOWERS

- A. Manufacturers:
  - 1. Aquatic
  - 2. Bradley Corp.
  - 3. Aquarius
  - 4. Lasco
  - 5. Aquaglass
  - 6. Eljer Plumbingware
  - 7. Kohler Co.
  - 8. Aquabath
  - 9. Comfort Designs
  - 10. Niagara.
- B. Trim: ASME A112.18.1; concealed shower supply with indexed handles, bent shower arm with flow control and adjustable spray ball joint showerhead with escutcheon.
- C. Trim: ASME A112.18.1; concealed shower supply with thermostatic mixing valves, integral service stops, bent shower arm with flow control and adjustable spray ball joint shower head with escutcheon.
- D. Trim: ASME A112.18.1; hand held shower with 69 inch 60 inch metal clad white reinforced vinyl hose and 51 inch 24 inch no slide bar, female inlet.
  - 1. Provide backflow protection in accordance with ASME A112.18.1 or by device complying with ASME 112.18.3.

2.6 ELECTRIC WATER COOLERS

- A. Manufacturers:
  - 1. Elkay
  - 2. Hasley Taylor
  - 3. Haws
  - 4. Acorn/Murdock
  - 5. Filtrine
  - 6. Oasis
  
- B. Fountain:
  - 1. ARI 1010; semi-recessed handicapped mounted electric water cooler with stainless steel top, stainless steel body, elevated anti-squirt bubbler with stream guard, automatic stream regulator, push button, mounting bracket, refrigerated with integral air cooled condenser and stainless steel grille and bottle filler.
  - 2. Capacity: gpm of 50 degrees F water with inlet at 80 degrees F and room temperature of 90 degrees F.
  - 3. All components of the electric water cooler in the wetted surface material shall be lead free in accordance with SDWA 1417.
  - 4. Furnish with cane apron and mounting bracket.

2.7 SERVICE SINKS

- A. Manufacturers:
  - 1. Acorn
  - 2. Fiat
  - 3. Kohler Co.
  - 4. Just
  
- B. Bowl: 36 x 24 x 10, 24x24x10 inch high molded stone, floor mounted, with one inch wide shoulders, vinyl bumper guard, stainless steel strainer.
  
- C. Trim: ASME A112.18.1 exposed wall type supply with cross lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral lead free screwdriver stops with covering caps and adjustable threaded wall flanges.
  
- D. Accessories:
  - 1. 5 feet of 1/2 inch diameter plain end reinforced plastic rubber hose.
  - 2. Hose clamp hanger.
  - 3. Mop hanger.

2.8 EMERGENCY EYE AND FACE WASH

- A. Manufacturers:
  - 1. Bradley Corp.
  - 2. Acorn
  - 3. Chicago Faucet Co.
  - 4. Encon Safety Products
  - 5. Haws Drinking Faucet Co.

6. Guardian
7. Speakman

- B. Eyewash: ANSI Z358.1; plastic stainless steel bowl with elbow, 1-1/4 inch galvanized steel pipe pedestal with floor flange, instant action stay open valve actuated by push flag l, twin spray heads with face spray ring, dust cover assembly, wall mount bracket, and tailpiece and chrome plated brass P-trap.

## 2.9 EMERGENCY COMBINATION SHOWER WITH EYE AND FACE WASH

- A. Manufacturers:
  1. Bradley Corp.
  2. Acorn
  3. Chicago Faucet Co.
  4. Encon Safety Products
  5. Haws Drinking Faucet Co.
  6. Guardian
  7. Speakman
- B. Shower: ANSI Z358.1; free standing, self- cleaning, non-clogging 8 inch diameter galvanized steel plastic drench shower head, instant action stay open valve actuated by rigid stainless steel pull rod.
- C. Eyewash: ANSI Z358.1; plastic stainless steel bowl with elbow, 1-1/4 inch galvanized steel pipe pedestal with floor flange, instant action stay open valve actuated by push flag l, twin spray heads with face spray ring, dust cover assembly, wall mount bracket, and tailpiece and chrome plated brass P-trap.
- D. Supply and Waste Piping: 1-1/4 inch galvanized steel stainless steel pipe pedestal with floor flange.
- E. Furnish universal emergency sign

## 2.10 LAVATORY INSULATION KIT

- A. Manufacturers:
  1. McGuire
  2. Truebro
  3. Plumerex
- B. Product Description: Where Lavatories are noted to be insulated for ADA compliance, furnish the following: Safety Covers conforming to ANSI A177.1 and consisting of insulation kit of molded closed cell vinyl construction, 3/16 inch thick, white color, for insulating tailpiece, P-trap, valves, and supply piping. Furnish with weep hole and angle valve access covers.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify walls and floor finishes are prepared and ready for installation of fixtures.
- C. Verify electric power is available and of correct characteristics.
- D. Confirm millwork is constructed with adequate provision for installation of counter top lavatories and sinks.

#### 3.2 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

#### 3.3 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible lead free supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports wall carriers and bolts.
- E. Seal fixtures to wall and floor surfaces with sealant as specified in Section 07 90 00, color to match fixture.
- F. Solidly attach water closets to floor with lag screws. Lead flashing is not intended hold fixture in place.
- G. For ADA accessible water closets, install flush valve with handle to wide side of stall.

#### 3.4 INTERFACE WITH OTHER PRODUCTS

- A. Review millwork shop-drawings. Confirm location and size of fixtures and openings before rough in and installation.

#### 3.5 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.6 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. Clean plumbing fixtures and equipment.

3.7 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Protecting installed construction.
- B. Do not permit use of fixtures before final acceptance.

END OF SECTION 224000

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SECTION 230400 GENERAL CONDITIONS FOR MECHANICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Section 01 91 13 – General Commissioning Requirements and related specification sections apply.
- C. Section 017419 - Construction and Demolition Waste Management and Disposal.
- D. Section 018113 - Sustainable Design Requirements.
- E. Section 018119 - Construction Indoor Air Quality Requirements.

1.2 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification
- B. LEED v4 Submittals: For all interior, wet-applied adhesives, sealants, paints and coatings related to the work of this Section, submit product and material documentation as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

1.3 DESCRIPTION

- A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division. Where conflicts exist between the drawings and the specifications or between

this section of the specifications and other sections, the more stringent or higher cost option shall apply.

- C. Demolition and renovation work shall be performed in accordance with SMACNA IAQ Guidelines for Occupied Buildings Under Construction.

#### 1.4 INTENT

- A. It is the intent of the Specifications and Drawings to call for finished work, tested and ready for operation.
- B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.
- C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.
- D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section includes the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

#### 1.5 DEFINITIONS

- A. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.
- B. "Approved equal" mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.
- C. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.
- D. "Finished" refers to all rooms and areas to be specified to receive architectural treatment as indicated on the drawings. All rooms and areas not covered, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.
- E. "Furnish" or "supply" shall mean purchase, deliver to, and off-load at the job site, ready to be installed including where appropriate all necessary interim storage and protection.



- F. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.
  - G. "Install" shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.
  - H. "Product" shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
  - I. "Provide" shall mean furnish (or supply) and install as necessary.
  - J. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
  - K. Remove: The term "remove" means " to disconnect from its present position, remove from the premises and to dispose of in a legal manner."
  - L. Special Warranties: The term "Special Warranties" are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.
  - M. Standard Product Warranties: The term "Standard Product Warranties" are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
  - N. "Subcontractor" means specifically the subcontractor working under this Division. Other Contractors are specifically designated "Plumbing Subcontractor", "General Contractor" and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.
  - O. Substitutions: Requests for changes in products, materials, equipment, and methods of construction proposed by the Contractor are considered requests for "substitutions."
  - P. "Wiring" shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.
- 1.6 DRAWINGS
- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)

- B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.
- C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

#### 1.7 CODES AND STANDARDS

- A. Reference Standard Compliance
  - 1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
  - 2. Independent Testing Organization Certificate: In lieu of the label or listing indicated above, submit a certificate from an independent testing organization, competent to perform testing, and approved by the Engineer. The certificate shall state that the item has been tested in accordance with the specified organization's test methods and that the item complies with the specified organization's reference standard.
- B. The Following Codes and Standards listed below apply to all mechanical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:
  - Connecticut State Building Code Including all Supplements
  - Connecticut State Fire Safety Code Including all Supplements
  - Connecticut Building Standards Guidelines – Compliance for High Performance Buildings
  - The International Building Code
  - The International Mechanical Code
  - The International Plumbing Code
  - The International Energy Conservation Code
  - The National Electrical Code
  - NFPA 101 Life Safety
  - ASHRAE 90.1 and International Energy Conservation Code

- C. The following Standards shall be used where referenced by the following abbreviations:
- |        |   |
|--------|---|
| AABC   | Associated Air Balance Council  |
| ACGIH  | American Conference of Governmental Industrial Hygienists                 |
| ADC    | Air Diffusion Council   |
| AGA    | American Gas Association  |
| AIA    | American Institute of Architects  |
| AMCA   | Air Moving and Conditioning Association                                   |
| ANSI   | American National Standards Institute                                     |
| API    | American Petroleum Institute  |
| ARI    | Air Conditioning and Refrigeration Institute                              |
| ASHRAE | American Society of Heating, Refrigerating and Air Conditioning Engineers |
| ASME   | American Society of Mechanical Engineers                                  |
| ASPE   | American Society of Plumbing Engineers                                    |
| ASSE   | American Society of Sanitary Engineers                                    |
| ASTM   | American Society of Testing and Materials                                 |
| AWS    | American Welding Society  |
| AWWA   | American Water Works Association  |
| CISPI  | Cast Iron Soil Pipe Institute   |
| EJMA   | Expansion Joint Manufacturing Association                                 |
| EPA    | Environmental Protection Agency   |
| FM     | Factory Mutual  |
| FSSC   | Federal Specification   |
| HIS    | Hydraulic Institute Standards   |
| IEEE   | Institute of Electrical and Electronics Engineers                         |
| IRI    | Industrial Risk Insurers  |
| ISO    | Insurance Services Office   |
| MCAA   | Mechanical Contractors Association of America                             |
| NBS    | National Bureau of Standards  |
| NEBB   | National Environmental Balancing Bureau                                   |
| NEMA   | National Electrical Manufacturers Association                             |
| NFPA   | National Fire Protection Association                                      |
| NOFI   | National Oil Fuel Institute   |
| NSC    | National Safety Council   |
| NSF    | National Sanitation Foundation  |
| OSHA   | Occupational Safety and Health Administration                             |
| PDI    | Plumbing and Drainage Institute   |
| SMACNA | Sheet Metal and Air Conditioning Contractors National Association         |
| UL     | Underwriters' Laboratories  |
- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.
- E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

1.8 PERMITS AND FEES

- A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

1.9 EQUIPMENT SUBSTITUTIONS

- A. In these Contract Documents, one or more makes of materials, apparatus or appliances may have been specified for use in this installation. These describe the basis of design and approved equivalents. This has been done for convenience in fixing the standard of workmanship, finish and design required for installation without consideration of any or all costs associated but not limited to (structural, mechanical, or electrical feeder, breaker, or transformer requirements). The Contractor acknowledges that not all requirements are shown for either alternate acceptable manufacturers listed or those alternates requiring a request for substitution and it is their responsibility to coordinate all requirements necessary to accommodate any change from the basis of design listed or scheduled. The contractor is required to submit any and all costs (including costs associated or required by all trades) along with performance differences as part of their request for substitution. The details of workmanship, finish and design, and the guaranteed performance of any material, apparatus or appliance which the Contractor desires to deviate for those mentioned herein shall also conform to these standards.
- B. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for the Engineers review.
- C. Where two or more names are given as approved manufacturers of equivalents, the Contractor must use the specified item or one of the named equivalents which still must meet all of the performance characteristics of the basis of design make and model. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.
- D. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the equipment or materials as hereinafter specified, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.

- E. Where the Contractor proposes to use an item of equipment other than specified or detailed on the Drawings which requires any redesign of the structure, partitions, foundations, piping, wiring or any other part of the mechanical, electrical or architectural layout, all such redesign and all new drawings and detailing required therefore shall be prepared by the Engineers/Architects of Record at the expense of the Contractor and at no additional cost to the Owner.
  
- F. Where such accepted deviation resulting from using an approved equivalent or substitution requires a different quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit and equipment from that specified or indicated on the Drawings, the Contractor shall, after acceptance by the Engineer, furnish and install any such additional equipment required by the system at no additional cost to the Owner, including any costs added to other trades due to the deviation.
  
- G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
  - 1. The equivalent shall have the same construction features such as, but not limited to:
    - a. Material thickness, gauge, weight, density, etc.
    - b. Welded, riveted, bolted, etc., construction
    - c. Finish, undercoating, corrosion protection
  - 2. The equivalent shall perform with the same or better operating efficiency.
  - 3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  - 4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.
  
- H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
  - 1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
  - 2. Submit three (3) copies of each request for substitution for consideration.
  - 3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
    - b. Samples, where applicable or requested.
    - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.

- d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors, that will become necessary to accommodate the proposed substitution.
- e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
- f. Cost information, including a proposal of the net change, if any in the Contract Sum.
- g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment or time, that may subsequently become necessary because of the failure of the substitution to perform adequately.
- h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
- i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
  - 1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.
  - 2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
  - 3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

1.10 SUBMITTAL PROCEDURES

- A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
  - 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
- C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
  - 1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
  - 2. If an intermediate submittal is necessary, process the same as the initial submittal.
  - 3. Allow two weeks for reprocessing each submittal.
  - 4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block. Submittals shall be arranged in order of specification sections.
  - 1. Include the following information on the label for processing and recording action taken.
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Number, title and paragraph of appropriate Specification Section.
    - i. Drawing number and detail references, as appropriate.
- E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements,



including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.

- F. Except for submittals for record, information or similar purposes, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.
- G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

#### 1.11 SHOP DRAWINGS

- A. Submit neatly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.
- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Mechanical Contract. Refer to Division 1 for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.
- C. Provide shop drawings for all devices specified under equipment specifications for all systems. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures), of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.
- D. When a submittal could involve more than one trade, e.g., valves, piping, etc., the submitted shall be separated by traded involved, ie. HVAC, plumbing, fire protection, etc.
- E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- F. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.



- G. “No Exception Taken” rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings. Review of shop drawings shall not apply to quantity of material.
- H. After shop drawings have been reviewed, with no exceptions taken, no further changes will be allowed without the written consent of the Engineer.
- I. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- J. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.
- K. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.
- L. Prepare sheetmetal and sprinkler shop drawings drawn in the latest AutoCAD version to a minimum scale of 1/4" = 1' - 0". Final approved drawings shall be turned over to the Owner on CD Rom, flash drive or other electronic version.
- M. Contractor shall be responsible for making all corrections in ACAD. Final record documents shall be prepared in the latest AutoCAD version. CD Rom, flash drive or other electronic version of all drawings and a clean set of hard copies shall be turned over to the Owner at the completion of the work.

#### 1.12 COORDINATION DRAWINGS

- A. Prepare coordination drawings drawn in the latest AutoCAD and BIM versions in accordance with Division 1 to a minimum scale of 1/4"=1'-0" detailing major elements, components, and systems of mechanical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. The Contractor shall indicate the proposed locations of piping, conduit, ductwork, equipment, and materials. Include the following:
    - a. Clearances for servicing and maintaining equipment, including tube removal, filter removal, and space for equipment disassembly required for periodic maintenance.
    - b. Equipment connections and support details.
    - c. Exterior wall and foundation penetrations.
    - d. Fire-rated wall and floor penetrations.
    - e. Sizes and locations of required concrete pads and bases.

- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.
- D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- E. The Contractor and each subcontractor shall sign and date each coordination drawing prior to submission.
- F. Work shall not be performed until coordination drawings have been approved by the architect and engineer.
- G. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files an Electronic Drawing File Release Form must be submitted. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic Drawing File Release Form, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the Electronic Drawing File Release Form is appended to the end of this specification section.

#### 1.13 COORDINATION WITH OTHER DIVISIONS

- A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.
- B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, HVAC piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.
- C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.
- D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.

1.14 WORKMANSHIP

- A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.
- B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, fitters, metal workers, welders, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.
- D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- E. All labor for installation of mechanical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

1.15 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.
- B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

1.16 TEMPORARY UTILITIES

- A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.

- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. First Aid Supplies: Comply with governing regulations.
- D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
- E. Utilities: Engage the appropriate local utility company to install temporary service or connect to existing service. Where the company provides only part of the service, provide the remainder with matching, compatible materials and equipment; comply with the company's recommendations.
  - 1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
- F. Water Service: Install water service and distribution piping of sizes and pressures adequate for construction until permanent water service is in use.
- G. Temporary Heat-Cool-Dehumidification: Provide temporary services required by construction activities, for curing or drying of completed installations or protection of installed construction from adverse effects of low temperatures or high humidity. Select safe equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate temporary services to produce the ambient condition required and minimize consumption of energy. The building's permanent HVAC systems shall not be used for these purposes. When propane is used for temporary heat, contractor shall be trained per state's department of public safety or equivalent requirements in storing, use and emergency planning of propane systems for temporary heat at construction sites. Documentation of trained personnel shall be kept on site.
- H. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.
- I. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

1.17 BUILDING FLUSH-OUT

- A. Building flush-out shall begin after construction ends and finishes are installed but prior to building occupancy. Prior to building flush-out, HVAC systems shall be balanced per Specification Section 23 05 93. Flush-out shall not occur until contractor receives permission to proceed from the Owner or Owner's representative.
- B. Commissioning and testing of the HVAC systems' temperature controls shall be allowed during the building flush out time frames prior to occupancy.
- C. Building flush-out procedures shall include continuously operating all the building's new ventilation systems at maximum design outside air flow rates. For constant volume HVAC systems, ventilation systems shall operate at maximum design supply air flow rates. HVAC systems shall be set to maintain internal space temperatures at minimum 60°F and maximum 78°F and relative humidity at maximum 60% RH.
- D. Compliance Path: Building flush-out prior to occupancy: HVAC systems shall operate continuously, 24 hours per day, for a minimum period of 32 days.
- E. Alternate Compliance Path: As an option, contractor may follow this option which requires flush-out prior to occupancy and allows flush-out to continue while building is occupied. Prior to occupancy, systems shall operate continuously (24 hours per day) for eight (8) days. When the building becomes occupied, systems shall operate 3 hours immediately prior to occupancy each day and then throughout the time period the building is occupied. Systems shall operate when building is occupied in this manner for another (24) days

1.18 PROJECT PHASING

- A. Work under each Section shall include all necessary temporary connections, equipment, piping, heating, temperature control work, fire stopping, water heaters, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building shall remain operational during all phases of construction. No extra compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

1.19 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include corrective actions to damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.

- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

#### 1.20 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Where requested by the Engineer, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer.

#### 1.21 CLEANING

- A. The Contractor shall thoroughly clean and flush all piping, ducts and equipment of all foreign substances, oils, burrs, solder, flux, etc., inside and out before being placed in operation.
- B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.
- C. During the course of construction, all ducts and pipes shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work. Any oil or grease stains on floor areas caused by the Contractor shall be removed and floor areas left clean.



- E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
  - 1. Remove labels that are not permanent labels.
  - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
  - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces.
  - 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean plumbing fixtures to a sanitary condition. Clean light fixtures and lamps.
  
- F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.
  
- G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

#### 1.22 OPERATING AND MAINTENANCE

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) days notice to the Owner and the Engineer in advance of this period.
  
- B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.
  
- C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.
  
- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. The following equipment will require this inspection: pumps; air conditioning equipment, controls, air handling equipment, compressors, boilers etc. These letters shall be bound into the operating and maintenance books.
  
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.

1.23 OPERATING AND MAINTENANCE MANUALS

- A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and requirements listed below. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty 3-ring vinyl-covered binders, with pocket folders for folded sheet information and designation partitions with identification tabs. Mark appropriate identification on front and spine of each binder.
  
- B. Manual shall include the following:
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing and operating instructions including lubrication charts and schedules.
  - 5. Emergency and safety instructions.
  - 6. Spare parts list.
  - 7. Copies of warranties.
  - 8. Wiring diagrams.
  - 9. Recommended "turn around" cycles.
  - 10. Inspection procedures.
  - 11. Approved Shop Drawings and Product Data.
  - 12. Equipment Start-up Reports.
  - 13. Temperature control diagrams and written sequences of operations.
  - 14. Balance reports.
  
- C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.
  
- D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

1.24 ACCEPTANCES

- A. The equipment, materials, workmanship, design and arrangement of all work installed under the Mechanical Sections shall be subject to the review of the Engineer.



- B. Within 30 days after the awarding of a Contract, the Mechanical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Mechanical Sections. The intent to use the exact manufacturers and models specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of award of the Contract. In such instances, equipment substitutions may be made pending acceptance by the Engineer or the Owner's representative.
- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Mechanical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

#### 1.25 RECORD DRAWINGS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.
- B. Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Give particular attention to concealed elements that would be difficult to measure and record at a later date. Items to be indicated include but are not limited to:
  - 1. Dimensional change
  - 2. Revision to drawing detail
  - 3. Location and depth of underground utility
  - 4. Revision to pipe routing
  - 5. Revision to electrical circuitry
  - 6. Actual equipment location
  - 7. Duct size and routing
  - 8. Location of concealed internal utility
  - 9. Changes made by Change Order

- 10. Details not on original Contract Drawing
  - 11. Information on concealed elements which would be difficult to identify or measure later
- C. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
  - D. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
  - E. Note related Change Order numbers where applicable.
  - F. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
  - G. Contractor shall be responsible for making all corrections in ACAD. Final record documents shall be prepared in the latest AutoCAD version. CD Rom, flash drive or other electronic version of all drawings and a clean set of hard copies shall be turned over to the Owner at the completion of the work.

#### 1.26 WARRANTIES AND BONDS

- A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
  - 1. General close-out requirements included in Division 1.
  - 2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted are included in the individual Sections of Divisions-2 through -16.
  - 3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

#### 1.27 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.

- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.
- D. Owner's Recourse: Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. Rejection of Warranties: The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.
- H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.
- I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
  - 1. Refer to individual Sections of Divisions-2 through -16 for specific content requirements, and particular requirements for submittal of special warranties.
- J. Form of Submittal: At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.

- K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
  - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
  - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.
  - 3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

#### 1.28 GUARANTEES

- A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineer's satisfaction.
- B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided.

#### 1.29 PROJECT CLOSE-OUT

- A. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents in accordance with Division 1.
- B. DEEP Equipment Forms: In addition to standard cut sheets for equipment, provide separate listing of all equipment along with tag, description, capacity ratings, model #, Serial #, etc. Forms shall be submitted electronically in spread sheet format
- C. Deliver tools, spare parts, extra stock, and similar items.
- D. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- E. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.

- F. Field Observation Procedures: On receipt of a request for an Engineers Field Observation, the Engineer will advise the Contractor of unfulfilled requirements. The Engineer will advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
1. The Engineer will repeat the Field Observation when requested and assured that the Work has been substantially completed.
  2. Results of the completed list of unfulfilled items will form the basis of requirements for final acceptance.

END OF SECTION 230400

**Electronic Drawing File Release Form**

DELIVERY OF FILES FOR: \_\_\_\_\_

Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ Client's Signature	_____ Date
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_____ Company - Title	
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_____ Architects' Signature	_____ Date
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_____ Firm - Title	
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_____ Owner's Signature	_____ Date
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_____ Company - Title	
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SECTION 230500 - COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Identification.
  - 2. Identification in Lower Level Mech. Room.
  - 3. Sleeves.
  - 4. Mechanical sleeve seals.
  - 5. Firestopping.
  - 6. Formed steel channels.
  - 7. Flashing.
  
- B. Related Sections:
  - 1. Division 3 - Concrete Forming and Accessories: Execution requirements for placement of sleeves in concrete forms specified by this section.
  - 2. Division 7 - Firestopping: Product requirements for firestopping for placement by this section.
  - 3. Division 7 - Joint Protection: Product requirements for sealant materials for placement by this section.
  - 4. Division 9 – Painting.
  - 5. Section 23 04 00 – General Conditions for Mechanical Trades
  - 6. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and execution requirements for vibration isolators.
  - 7. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME B31.1 - Power Piping.
  - 2. ASME B31.9 - Building Services Piping.
  
- B. ASTM International:
  - 1. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
  - 2. ASTM E814 - Standard Test Method for Fire Tests of Through Penetration Fire Stops.
  - 3. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
  - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
  
- C. American Welding Society:
  - 1. AWS D1.1 - Structural Welding Code - Steel.

- D. FM Global:
  - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
- E. Underwriters Laboratories Inc.:
  - 1. UL 263 - Fire Tests of Building Construction and Materials.
  - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
  - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
  - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
  - 5. UL - Fire Resistance Directory.

### 1.3 SUBMITTALS

- A. Shop Drawings: Submit for identification list of wording, symbols, letter size, and color coding for pipe and ductwork identification and valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- B. Product Data for Identification: Submit for mechanical identification and mechanical sleeve seals manufacturers catalog literature for each product required.

### 1.4 DEFINITIONS

- A. Firestopping (Through-Penetration Protection System): Sealing or stuffing material or assembly placed in spaces between and penetrations through building materials to arrest movement of fire, smoke, heat, and hot gases through fire rated construction.

### 1.5 SYSTEM DESCRIPTION

- A. Firestopping Materials: ASTM E119 or UL 263 to achieve fire ratings as noted on Drawings for adjacent construction, but not less than 1 hour fire rating. Firestopping Materials: ASTM E119, UL 263, to achieve fire ratings of adjacent construction
- B. Firestop interruptions to fire rated assemblies, materials, and components.

### 1.6 PERFORMANCE REQUIREMENTS

- A. Firestopping: Conform to applicable code for fire resistance ratings and surface burning characteristics.
- B. Firestopping: Provide certificate of compliance from authority having jurisdiction indicating approval of materials used.

### 1.7 QUALITY ASSURANCE

- A. Through Penetration Firestopping of Fire Rated Assemblies: UL 1479 or ASTM E814 with 0.10 inch water gage minimum positive pressure differential to achieve fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
  - 1. Wall Penetrations: Fire F-Ratings as indicated on Drawings, but not less than 1-hour.



2. Floor and Roof Penetrations: Fire F-Ratings and temperature T-Ratings as indicated on Drawings, but not less than 1-hour.
  - a. Floor Penetrations Within Wall Cavities: T-Rating is not required.
- B. Through Penetration Firestopping of Non-Fire Rated Floor and Roof Assemblies: Materials to resist free passage of flame and products of combustion.
  1. Noncombustible Penetrating Items: Noncombustible materials for penetrating items connecting maximum of three stories.
  2. Penetrating Items: Materials approved by authorities having jurisdiction for penetrating items connecting maximum of two stories.
- C. Fire Resistant Joints in Fire Rated Floor, Roof, and Wall Assemblies: ASTM E1966 or UL 2079 to achieve fire resistant rating as indicated on Drawings for assembly in which joint is installed.
- D. Fire Resistant Joints Between Floor Slabs and Exterior Walls: ASTM E119 with 0.10 inch water gage minimum positive pressure differential to achieve fire resistant rating as indicated on Drawings for floor assembly.
- E. Surface Burning Characteristics: Maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- F. Maintain one copy of each document on site.

## PART 2 PRODUCTS

### 2.1 IDENTIFICATION

- A. Manufacturers:
  1. Seton Identification Products
  2. Craftmark Identification Systems
  3. Safety Sign Co.
- B. Plastic Nameplates: Laminated three-layer plastic with engraved black letters on light background color.
- C. Plastic Tags and Plastic Valve Tags: Laminated three-layer plastic with engraved black letters on light background color, minimum 1-1/2 inches diameter.
- D. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener. Color and Lettering: Conform to ASME A13.1.
- E. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings. Color and Lettering: Conform to ASME A13.1.

- F. Underground Pipe Markers: Provide manufacturer's standard permanent, bright-colored, continuous-printed plastic tape, intended for direct-burial service; not less than 6" wide x 4 mils thick. Provide tape with printing which most accurately indicates type of service of buried pipe. Provide multi-ply tape consisting of solid aluminum foil core between 2-layers of plastic tape
- G. Ductwork Markers: Identify ductwork with duct markers; or provide stenciled signs and arrows, showing ductwork service and direction of flow, in black or white (whichever provides most contrast with ductwork color).
- H. Painting of piping in accordance with Division 9.

## 2.2 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Schedule 40 steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for Round Ductwork: Galvanized steel.
- D. Sleeves for Rectangular Ductwork: Galvanized steel.
- E. Sealant: Acrylic for non-fire rated penetrations.
- F. Escutcheons: The Contractor shall provide chrome plated escutcheons on pipes, conduit and ductwork wherever they pass through floors, ceilings, walls or partitions in finished locations.

## 2.3 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
  - 1. Thunderline Link-Seal, Inc.
  - 2. Fernco
  - 3. BWM
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

## 2.4 FORMED STEEL CHANNEL

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. B-Line Systems
  - 3. Unistrut Corp.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

2.5 FLASHING

- A. Metal Flashing: 26 gage thick galvanized steel.
- B. Metal Counterflashing: 22 gage thick galvanized steel.
- C. Lead Flashing:
  - 1. Waterproofing: 5 lb./sq. ft sheet lead.
  - 2. Soundproofing: 1 lb./sq. ft sheet lead.
- D. Flexible Flashing: 47 mil thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify openings are ready to receive sleeves.

3.2 INSTALLATION – IDENTIFICATION FOR HVAC WORK

- A. Install plastic nameplates with adhesive for equipment and devices located inside the building.
- B. Install plastic nameplates with rivets for equipment and devices located outside the building.
- C. Install plastic tags with corrosion resistant metal chain.
- D. Pipe markers shall be color coded and shall identify the pipe size, type of piping system and direction of flow. Markers shall be located as listed below wherever piping is exposed to view in occupied spaces, mechanical rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations:
  - 1. Near each valve, control device, major equipment items and points of origination and termination
  - 2. Near each branch, excluding short take-offs for fixtures and terminal units; mark each pipe at branch, where there could be question of flow pattern.
  - 3. Near locations where pipes pass through walls or floors/ceilings, or enter non-accessible enclosures.
  - 4. At access doors, manholes and similar access points which permit view of concealed piping.
  - 5. Spaced intermediately at maximum spacing of 50' along each piping run, except reduce spacing to 25' in congested areas of piping and equipment.
  - 6. On piping above removable acoustical ceilings, except omit intermediately spaced markers.

- E. Piping in Lower Level Mechanical Room: All piping shall be painted in accordance with following color schemes as approved by Owner. All piping shall have additional pipe labels.
  - 1. GWS&R: Green
  - 2. CHWS&R: Blue
  - 3. HWS&R: Orange
  - 4. Commons S&R off heat pumps to three way valves: White
  - 5. S&R piping serving domestic hot water: Yellow.
  
- F. Ductwork in Lower Level Mechanical Room: All ductwork be painted in accordance with following color schemes as approved by Owner and shall have additional labels.
  - 1. Supply Air: Green
  - 2. Return Air: Yellow
  - 3. Outside Air: Blue
  - 4. Exhaust Air and Relief Air: Orange
  
- G. Equipment at Lower Level Mechanical Room: All equipment shall be labeled with plastic nameplates with minimum 4" high lettering. Color of nameplates shall match piping colors listed above.
  
- H. Ductwork at Lower Level Mechanical Room: All equipment shall be labeled with plastic nameplates with minimum 4" high lettering. Color of nameplates shall match piping colors listed above.
  
- I. Ductwork markers shall be provided:
  - 1. Ductwork markers shall be color coded and shall identify the type of system and direction of flow.
  - 2. In each space where ductwork is exposed, or concealed only by removable ceiling system, locate signs near points where ductwork originates or continues into concealed enclosures (shaft, underground or similar concealment), and at 50' spacing along exposed runs. Locate identification at air handling equipment.
  - 3. Provide duct markers or stenciled signs on each access door in ductwork and housings, indicating purpose of access (fire damper, temperature sensor, etc.) and other maintenance and operating instructions, and appropriate safety and procedural information.
  - 4. Access doors for fire dampers shall be permanently identified on the exterior by a label having letter not less the 0.5 inches in height reading "FIRE DAMPER", etc.
  
- J. Underground Pipe Markers: During back-filling/top-soiling of each exterior underground piping systems, install continuous underground-type plastic line marker, located directly over buried line at 6" to 8" below finished grade. Where multiple small lines are buried in common trench and do not exceed overall width of 16", install single line marker. For tile fields and similar installations, mark only edge pipe lines of field.
  
- K. Plastic Tags and Plastic Valve Tags:
  - 1. Provide valve tag on every valve, cock and control device in each piping system; exclude check valves, valves within factory-fabricated equipment units, HVAC terminal devices and similar rough-in connections of end-use fixtures and units.

List each tagged valve in valve schedule for each piping system. For each page of valve schedule, provide glazed display frame, with screws for removable mounting on masonry walls.

2. Submit valve schedule for each piping system, typewritten and reproduced on 8-1/2" x 11" bond paper. Tabulate valve number, piping system, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification (if any). Mark valves which are intended for emergency shut-off and similar special uses, by special "flags", in margin of schedule. In addition to mounted copies, furnish extra copies for Maintenance Manuals as specified in Division 1.

- L. Mechanical identification work shall comply with ANSI A13.1. Names, abbreviations and other designations used in mechanical identification work, shall correspond with designations shown on drawings, specified or scheduled.
- M. Piping, valves and controls in all rooms housing equipment with refrigerants shall be labeled per ASHRAE 15 – Safety Standard for Refrigeration Systems.

### 3.3 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with mechanical sleeve seals.
- B. Set sleeves in position in forms. Provide reinforcing around sleeves.
- C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- D. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- E. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with firestopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- F. Mechanical Sleeve Seal: When piping or conduit penetrate a wall below grade, the floor of a mechanical room located above an occupied space, or other locations where water may cause damage, such penetrations shall be made completely watertight with mechanical sleeve seal, such that a liquid leak shall not pass through the penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

### 3.4 INSTALLATION – FLASHING AND CURBS

- A. Provide flexible flashing and metal counter-flashing where piping and ductwork penetrate weather or waterproofed walls, floors, and roofs.
- B. Where multiple pipes penetrate the roof at one location, provide a minimum 30" high roof curb. Piping shall penetrate side wall of the roof curb. Seal and flash each pipe as it penetrates the wall of the curb. In addition, provide aluminum rain shield over side wall piping where it penetrates the curb.

- C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms for sound control.
- D. Provide curbs for roof installations 12 inches minimum high above roofing surface. Flash and counter-flash with sheet metal; seal watertight. Attach counter-flashing to equipment and lap base flashing on roof curbs. Flatten and solder joints.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

### 3.5 INSTALLATION - FIRESTOPPING

- A. Install material at fire rated construction perimeters and openings containing penetrating sleeves, piping, ductwork, and other items, requiring firestopping.
- B. Apply primer where recommended by manufacturer for type of firestopping material and substrate involved, and as required for compliance with required fire ratings.
- C. Apply firestopping material in sufficient thickness to achieve required fire and smoke rating, to uniform density and texture.
- D. Place foamed material in layers to ensure homogenous density, filling cavities and spaces. Place sealant to completely seal junctions with adjacent dissimilar materials.
- E. Remove dam material after firestopping material has cured.
- F. Fire Rated Surface:
  - 1. Seal opening at floor, wall, partition, ceiling, and roof as follows:
    - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
    - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
    - c. Pack void with backing material.
    - d. Seal ends of sleeve with UL listed fire resistive silicone compound to meet fire rating of structure penetrated.
  - 2. Where bus, conduit, wireway, penetrates fire rated surface, install firestopping product in accordance with manufacturer's instructions.
- G. Non-Rated Surfaces:
  - 1. Seal opening through non-fire rated wall, partition floor, ceiling, and roof opening as follows:
    - a. Install sleeve through opening and extending beyond minimum of 1 inch on both sides of building element.
    - b. Size sleeve allowing minimum of 1 inch void between sleeve and building element.
    - c. Install type of firestopping material recommended by manufacturer.
  - 2. Install escutcheons or ceiling plates where conduit, penetrates non-fire rated surfaces in occupied spaces. Occupied spaces include rooms with finished ceilings and where penetration occurs below finished ceiling.

3. Exterior wall openings below grade: Assemble rubber links of mechanical sealing device to size of piping and tighten in place, in accordance with manufacturer's instructions.
4. Interior partitions: Seal pipe penetrations at data rooms. Apply sealant to both sides of penetration to completely fill annular space between sleeve and conduit.

END OF SECTION 230500

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SECTION 230513 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes single- and three-phase motors for application on equipment provided under other sections and for motors furnished loose to Project.
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
  - 3. Section 26 05 53 - Identification for Electrical Systems.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
  - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- B. National Electrical Manufacturers Association:
  - 1. NEMA MG 1 - Motors and Generators.
- C. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit catalog data for each motor furnished loose. Indicate nameplate data, standard compliance, electrical ratings and characteristics, and physical dimensions, weights, mechanical performance data, and support points.
- C. Test Reports: Indicate procedures and results for specified factory and field testing and inspection.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Testing Agency: Company member of International Electrical Testing Association and specializing in testing products specified in this section with minimum three years documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Lift only with lugs provided. Handle carefully to avoid damage to components, enclosure, and finish.
- C. Protect products from weather and moisture by covering with plastic or canvas and by maintaining heating within enclosure.
- D. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 PRODUCTS

2.1 MOTORS

- A. Manufacturers:
  - 1. Baldor Electric.
  - 2. General Electric.
  - 3. Marathon Electric.
  - 4. Reliance Electric
- B. Motors 3/4 hp and Larger: Three-phase motor except where specifically noted otherwise.
- C. Visible Nameplate: Indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, efficiency.
- D. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated.
- E. Three-Phase Motors: NEMA MG 1, Design B, energy-efficient squirrel-cage induction motor, with windings to accomplish starting methods and number of speeds as indicated on Drawings.
  - 1. 60 Hertz except where specifically noted otherwise.
  - 2. Enclosure: Meet conditions of installation.
  - 3. Design for continuous operation in 40 degrees C environment, with temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
  - 4. Insulation System: NEMA Class B or better.
  - 5. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
  - 6. Thermistor System (Motor Frame Sizes 254T and Larger): Three PTC thermistors embedded in motor windings and epoxy encapsulated solid state control relay with wiring to terminal box.
  - 7. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum ABMA 9, L-10 life of 200,000 hours. Calculate bearing load with NEMA minimum V-belt pulley

with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.

8. Sound Power Levels: Conform to NEMA MG 1.

F. Single Phase Motors:

1. Permanent split-capacitor type where available, otherwise use split-phase start/capacitor run or capacitor start/capacitor run motor.
2. 60 Hertz except where specifically noted otherwise
3. Starting Torque: Exceeding one fourth of full load torque.
4. Starting Current: Up to six times full load current.
5. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, pre-lubricated sleeve or ball bearings, automatic reset overload protector.

2.2 MISCELLANEOUS SPECIALTIES

- A. 2 HP and larger: All motors shall be provided with AEGIS SGR bearing protection ring or approved equal; factory installed in the motor housing.
- B. Inverter Duty Rated Motors: Totally enclosed blower cooled (TEBC) with Class H insulation, two normally closed thermal protectors, 1800 rpm for belt drive application. Blower motor shall be 230/460 volt, three phase.
- C. EC Motors shall be an electronically commutated motor rated for continuous duty and furnished either with internally mounted potentiometer speed controller or with leads for connection to 0-10 VDC external controller.
- D. Multiple Speed Motors: Through tapped windings.

2.3 SOURCE QUALITY CONTROL

- A. Test motors in accordance with NEMA MG 1, including winding resistance, no-load speed and current, locked rotor current, insulation high-potential test, and mechanical alignment tests.

2.4 EFFICIENCY

- A. All motors shall be "Premium Efficiency" with minimum efficiencies as required by the local utility company's current rebate program. The nominal efficiency shall be stamped on the nameplate in accordance with NEMA Standard MG. 1.

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- B. Install engraved plastic nameplates in accordance with Section 26 05 53.
- C. Ground and bond motors in accordance with Section 26 05 26.

3.2 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.15.

END OF SECTION 230513

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Design of expansion system and anchors.
  - 2. Expansion joints.
  - 3. Expansion compensators.
  - 4. Pipe alignment guides.
  - 5. Swivel joints.
  - 6. Pipe anchors.
  
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for piping hangers and supports.
  - 3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and installation requirements for vibration isolators used in piping systems.
  - 4. Section 23 21 13 - Hydronic Piping: Product and installation requirements for piping used in hydronic heating and cooling systems.
  - 5. Section 33 23 13 – Geothermal Energy Exchange piping: Product and installation requirements for piping used in geo thermal loop.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME B31.1 - Power Piping.
  - 2. ASME B31.9 - Building Services Piping.
  - 3. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
  
- B. American Welding Society:
  - 1. AWS D1.1 - Structural Welding Code - Steel.

1.3 DESIGN REQUIREMENTS

- A. Provide design, details, work and equipment required for expansion and contraction of hydronic piping systems. Verify anchors, guides, and expansion joints provide and adequately protect system.
  
- B. Provide structural work and equipment required for expansion and contraction of piping. Verify anchors, guides, and expansion joints provide and adequately protect system.

- C. Expansion Compensation Design Criteria:
  - 1. Installation Temperature: 50 degrees F.
  - 2. Hot Water Heating System Temperature: 150 degrees F.
  - 3. Ground water system Temperature: 90 degrees F.
  - 4. Safety Factor: 30 percent.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Pipe Expansion Analysis, Design and Certification:
  - 1. Provide pipe expansion and anchoring calculations for all hydronic piping systems including connections to equipment and to the structure. Piping layouts and associated calculations must be stamped by a registered professional engineer with at least five years of pipe expansion experience, licensed in the State of Connecticut.
  - 2. Analysis must indicate calculated dead loads, active expansion loads and capacity of materials utilized for connections to equipment and structure. Analysis must detail anchoring methods, bolt diameter, embedment and/or welded length. All expansion and anchoring devices shall be designed to accept the forces as calculated.
- C. Shop Drawings: Indicate layout of piping systems, including flexible connectors, expansion joints, expansion compensators, loops, offsets and swing joints.
- D. Product Data:
  - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
  - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.
- E. Design Data: Indicate criteria and show calculations. Submit calculations sealed by a registered professional engineer; licensed in the State of Connecticut.
- F. Manufacturer's Installation Instructions: Submit special procedures.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of flexible pipe connectors, expansion joints, anchors, and guides.
- C. Operation and Maintenance Data: Submit adjustment instructions.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with ASME B31.1 code for installation of piping systems and ASME Section IX for welding materials and procedures.
- B. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.
- C. Design expansion compensating system under direct supervision of Professional Engineer experienced in design of this Work and licensed in state which the Work will occur.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept expansion joints on site in factory packing with shipping bars and positioning devices intact. Inspect for damage.
- C. Protect equipment from exposure by leaving factory coverings, pipe end protection, and packaging in place until installation.

1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish one year manufacturer warranty for leak free performance of packed expansion joints starting from date of Substantial Completion.

PART 2 PRODUCTS

2.1 EXPANSION JOINTS

- A. Manufacturers:
  - 1. Novia
  - 2. Mason
  - 3. Metraflex
  - 4. Vibration Elimination

- B. Carbon Steel Expansion Compensator:
  - 1. Mason Mercer ECFFL / ECMN or approved equal.
  - 2. Externally pressurized expansion compensator with 2 ply 304 stainless steel bellows in carbon steel casing,
  - 3. Maximum Temperature: 300 degrees F at 170 psig.
  - 4. Joint: Flanged or threaded carbon steel.
  
- C. Copper Expansion Compensator:
  - 1. Mason Mercer ECCPS or approved equal.
  - 2. Externally pressurized expansion compensator with 2 ply, 304 stainless steel bellows in stainless steel casing
  - 3. Maximum Temperature: 300 degrees F at 170 psig.
  - 4. Joint: copper sweat ends.

## 2.2 ACCESSORIES

- A. Manufacturers:
  - 1. Novia
  - 2. Mason
  - 3. Metraflex
  - 4. Vibration Elimination
  
- B. Pipe Alignment Guides: Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inch travel.
  
- C. Pipe Anchors: All-directional acoustical pipe anchor, consisting of two sizes of steel tubing separated by a minimum 1/2" (12mm) thick 60 durometer neoprene. Vertical restraint shall be provided by similar material arranged to prevent vertical travel in either direction. Allowable loads on the isolation material should not exceed 500 psi (.35 kg/mm<sup>2</sup>) and the design shall be balanced for equal resistance in any direction.
  
- D. Swivel Joints: Bronze body, double ball bearing race, field lubricated, with rubber (Buna-N) o-ring seals.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Install Work in accordance with ASME B31.1.
  
- B. Rigidly anchor pipe to building structure. Provide pipe guides to direct movement only along axis of pipe. Erect piping so strain and weight is not on cast connections or apparatus.



- C. Provide support and anchors for controlling expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required. Refer to Section 23 05 29 for pipe hanger installation requirements.
- D. For systems using grooved piping systems, provide with minimum one joint per inch pipe diameter instead of flexible connector supported by vibration isolation..
- E. Provide piping expansion joints or expansion loops as indicated on Drawings and as scheduled below:
  1. Provide and install pipe expansion joints or expansion loops at all conditions listed below and as required to minimize stress on the piping systems.
  2. Provide pipe guides at inlet and outlet of each expansion joint and expansion loop.
  3. Where expansion joints or loops are required, provide pipe anchors at ends of each straight length of run.
  4. Provide and install expansion joints, expansion loops, pipe guides and anchors per ASHRAE Guidelines and manufacturer's recommendations.

PIPING SYSTEM	PIPING MATERIAL	PIPE SIZE	Condition Requiring expansion joint or expansion loop (all conditions assume "offset leg" at end of runs are minimum 12'0" long)
Supply and return	Copper	Up to 3 inches	All straight sections of piping over 90' long.
Supply and return	Steel	Up to 2 inches	All straight sections of piping over 140' long.
Supply and return	Steel	2" to 4"	All straight sections of piping over 90' long

### 3.2 MANUFACTURER'S FIELD SERVICES

- A. Section 01 40 00 - Quality Requirements: Manufacturers' field services.
- B. Furnish inspection services by flexible pipe manufacturer's representative for final installation and certify installation is in accordance with manufacturer's recommendations and connectors are performing satisfactorily.

END OF SECTION 230516

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SECTION 230523 - GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Gate valves.
  - 2. Globe valves.
  - 3. Ball valves.
  - 4. Butterfly valves.
  - 5. Check valves.
  
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product and installation requirements for pipe hangers and supports.
  - 3. Section 23 07 00 - HVAC Insulation: Product and installation requirements for insulation for valves.
  - 4. Section 23 21 13 - Hydronic Piping: Product and installation requirements for piping used in hydronic piping systems.
  - 5. Section 23 21 16 - Hydronic Piping Specialties: Product and installation requirements for piping specialties used in hydronic piping systems.

1.2 REFERENCES

- A. ASTM International:
  - 1. ASTM A216/A216M - Standard Specification for Steel Castings, Carbon, Suitable for Fusion Welding, for High-Temperature Service.
  - 2. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  - 3. ASTM D4101 - Standard Specification for Propylene Injection and Extrusion Materials.
  
- B. Manufacturers Standardization Society of the Valve and Fittings Industry:
  - 1. MSS SP 67 - Butterfly Valves.
  - 2. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
  - 3. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
  - 4. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
  - 5. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
  - 6. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
  - 7. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit manufacturers catalog information with valve data and ratings for each service. Valve pressure and temperature ratings shall be in accordance with pressure and temperature ratings of systems they serve.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of valves.
- C. Operation and Maintenance Data: Submit installation instructions, spare parts lists, exploded assembly views.

1.5 QUALITY ASSURANCE

- A. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Do not install valves underground when bedding is wet or frozen.

1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for warranties.
- B. Furnish one year manufacturer warranty for valves excluding packing.

PART 2 PRODUCTS

2.1 GATE VALVES

- A. Manufacturers:
  - 1. Crane Valve, North America.
  - 2. Milwaukee Valve Company.
  - 3. NIBCO, Inc.
  - 4. Stockham Valves & Fittings Model.
  - 5. Watts
- B. 2 inches and Smaller: MSS SP 80, Class 125 / 250, bronze body, bronze trim, threaded union bonnet, non-rising stem, hand-wheel, solid wedge disc, solder o threaded ends.
- C. 2-1/2 inches and Larger: MSS SP 70, Class 125 / 250, iron body, bronze trim, bolted bonnet, non-rising stem, hand-wheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.2 GLOBE VALVES

- A. Manufacturers:
  - 1. Crane Valve, North America
  - 2. Milwaukee Valve Company
  - 3. NIBCO, Inc.
  - 4. Stockham Valves & Fittings
  - 5. Watts
- B. 2 inches and Smaller: MSS SP 80, Class 125, bronze body, bronze trim, threaded bonnet, hand wheel, Buna-N composition disc, threaded ends.
- C. 2-1/2 inches and Larger: MSS SP 85, Class 125, cast iron body, bronze trim, hand wheel, outside screw and yoke, flanged ends. Furnish chain-wheel operators for valves 6 inches and larger mounted over 8 feet above floor.

2.3 BALL VALVES

- A. Manufacturers:
  - 1. Crane Valve, North America
  - 2. Jamesbury
  - 3. NIBCO, Inc.

4. Stockham Valves & Fittings
  5. Watts
- B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder or threaded ends with union, lever handle.
- C. 2-1/2 inches and Larger: MSS SP 110, Class 150, bronze, three piece body, type 316 stainless steel ball, full port, teflon seats, blow-out proof stem, solder or threaded ends, lever handle.

#### 2.4 BALL VALVES (Press Style)

- A. Manufacturers:
1. Viega
  2. Milwaukee Valve Company
  3. Watts
  4. Substitutions: Not Permitted.
- B. 2 inches and Smaller: MSS SP 110, Class 150, bronze, two piece body, chrome plated bronze ball, regular port, teflon seats, blow-out proof stem and lever handle.
- C. Press Fitting: Copper press fitting shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Sealing elements for copper or copper alloy press fittings shall be EPDM.

#### 2.5 BUTTERFLY VALVES

- A. Manufacturers:
1. Crane Valve, North America
  2. Keystone
  3. NIBCO, Inc.
  4. Stockham Valves & Fittings
  5. Centerline.
  6. Norriseal.
- B. 2-1/2 inches and Larger: MSS SP 67, Class 150.
1. Body: Cast or ductile iron, wafer or lug ends, stainless steel stem, extended neck.
  2. Disc: Aluminum bronze.
  3. Seat: Resilient replaceable EPDM.
  4. Handle and Operator: 10 position lever handle. Furnish gear operators for valves 8 inches and larger, and chain-wheel operators for valves mounted over 8 feet above floor.

## 2.6 PLUG VALVES

- A. Manufacturers:
  - 1. DeZURIK, Unit of SPX Corp.
  - 2. Flow Control Equipment, Inc.
  - 3. Homestead Valve
- B. Furnish materials in accordance with Owner's guidelines.
- C. MSS SP 78, Class 150, semi-steel construction, square or rectangular port, full pipe area, pressure lubricated, teflon packing, threaded ends. Furnish one plug valve wrench for every ten plug-valves with minimum of one wrench. Provide with threaded ends for 2" and smaller and flanged ends for sizes over 2".

## 2.7 SWING CHECK VALVES

- A. Horizontal Swing Check Valves:
  - 1. Manufacturers:
    - a. Crane Valve, North America
    - b. Milwaukee Valve Company
    - c. NIBCO, Inc.
    - d. Stockham Valves & Fittings
    - e. Watts
  - 2. 2 inches and Smaller: MSS SP 80, Class 150 body and cap, bronze seat, Buna-N disc, solder or threaded ends.
  - 3. 2-1/2 inches and Larger: MSS SP 71, Class 125 cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.
- B. Spring Loaded Check Valves:
  - 1. Manufacturers:
    - a. Crane Valve, North America
    - b. Milwaukee Valve Company
    - c. NIBCO, Inc.
    - d. Stockham Valves & Fittings
    - e. Watts
  - 2. Class 125, aluminum bronze disc, Buna-N seat, split plate, hinged with stainless steel spring, resilient seal bonded to body. Pressure drop shall not exceed 1 psig at design flow.

## 2.8 CHECK VALVES (Press Style Fittings)

- A. Spring Loaded Check Valves :
  - 1. Manufacturers:
    - a. Viega
    - b. Milwaukee Valve Company
    - c. Watts
    - d. Substitutions: Not Permitted.

2. 2 inches and Smaller: MSS SP 80, Class 250, bronze body, in-line spring lift check, silent closing, Buna-N disc, integral seat.
3. Press Fitting: Copper press fitting shall conform to the material and sizing requirements of ASME B16.18 or ASME B16.22. Sealing elements for copper or copper alloy press fittings shall be EPDM.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify piping system is ready for valve installation.

#### 3.2 INSTALLATION

- A. Install valves with stems upright or horizontal, not inverted.
- B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.
- C. Install 3/4 inch ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.
- D. Install valves with clearance for installation of insulation and allowing access.
- E. Use gate, ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- F. Use globe valves for throttling, bypass, or manual flow control services.
- G. Use 3/4 inch gate or ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment. In mechanical rooms, pipe to nearest floor drain.
- H. Use horizontal swing check valves on discharge of pumps.
- I. Provide access where valves and fittings are not accessible. Coordinate size and location of access doors with Section 08 31 13.
- J. Refer to Section 23 05 29 for pipe hangers.
- K. Refer to Section 23 07 00 for insulation requirements for valves.



3.3 INSTALLATION – PRESS STYLE FITTINGS

- A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) recommended by the manufacturer. Contractor shall be trained on the use and installation of the system by manufacturer's representative.

3.4 VALVE APPLICATIONS / GENERAL INFO

- A. Provide valve charts posted in frames behind plexi-glass. Charts shall be installed in Mech Rooms and shall include piping diagrams keyed to listing of valves.
- B. Install shutoff and drain valves at locations indicated on Drawings in accordance with this Section.
- C. Install ball, butterfly or gate valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- D. Install ball butterfly or globe valves for throttling, bypass, or manual flow control services.
- E. Install spring loaded check valves on discharge of water pumps.

END OF SECTION 230523

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SECTION 230529 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Pipe hangers and supports.
  - 2. Hanger rods.
  - 3. Inserts.
  
- B. Related Sections:
  - 1. Section 03 10 00 - Concrete Forming and Accessories: Execution requirements for placement of sleeves in concrete forms specified by this section.
  - 2. Section 23 04 00 – General Conditions for Mechanical Trades
  - 3. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product and execution requirements for vibration isolators.
  - 4. Section 23 21 13 - Hydronic Piping: Execution requirements for placement of hangers and supports specified by this section.

1.2 REFERENCES

- A. American Society of Mechanical Engineers:
  - 1. ASME B31.1 - Power Piping.
  - 2. ASME B31.9 - Building Services Piping.
  
- B. ASTM International:
  
- C. American Welding Society:
  - 1. AWS D1.1 - Structural Welding Code - Steel.
  
- D. Manufacturers Standardization Society of the Valve and Fittings Industry:
  - 1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
  - 2. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
  - 3. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Shop Drawings: Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
  
- C. Product Data:
  - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.

- D. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
  - E. Manufacturer's Installation Instructions:
    - 1. Hangers and Supports: Submit special procedures and assembly of components.
  - F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.4 QUALITY ASSURANCE
- A. Perform Work in accordance with applicable authority for welding hanger and support attachments to building structure.
- 1.5 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.
  - B. Installer: Company specializing in performing Work of this section approved by manufacturer.
- 1.6 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
  - B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
  - C. Protect from weather and construction traffic, dirt, water, chemical, and damage, by storing in original packaging.
- 1.8 ENVIRONMENTAL REQUIREMENTS
- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
  - B. Do not apply firestopping materials when temperature of substrate material and ambient air is below 60 degrees F.
  - C. Maintain this minimum temperature before, during, and for minimum 3 days after installation of firestopping materials.

- D. Provide ventilation in areas to receive solvent cured materials.

## 1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

## PART 2 PRODUCTS

### 2.1 PIPE HANGERS AND SUPPORTS

#### A. Manufacturers:

1. Flex-Weld, Inc.
2. Globe Pipe Hanger Products Inc.
3. Superior Valve Co.
4. Grinnell Corp.
5. Creative Systems Inc.
6. Superior Valve Co.

#### B. Hydronic Piping:

1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69, or MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Carbon steel, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches and Larger: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches: Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 5 inches and Larger: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 5 inches and Larger: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes 3 inches and Smaller: Cast iron hooks.
9. Wall Support for Pipe Sizes 4 inches and Larger: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 5 inches and Larger: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes 4 Inches and Smaller: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 5 inches and Larger: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Copper-plated, carbon steel ring.

### 2.2 ACCESSORIES

- A. Hanger Rods: Mild steel threaded both ends, threaded on one end, or continuous threaded.

### 2.3 INSERTS

- A. Manufacturers:
  - 1. Thunderline Link Seal
  - 2. Fernco
  - 3. BWM
  - 4. Substitutions: Section 01 60 00 - Product Requirements.
  
- B. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
  
- B. Verify openings are ready to receive sleeves.

### 3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
  
- B. Remove incompatible materials affecting bond.
  
- C. Install backing damming materials to arrest liquid material leakage.
  
- D. Obtain permission from Architect/Engineer before using powder-actuated anchors.
  
- E. Do not drill or cut structural members.
  
- F. Obtain permission from Architect/Engineer before drilling or cutting structural members.

### 3.3 INSTALLATION - INSERTS

- A. Install inserts for placement in concrete forms.
  
- B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.
  
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above flush with top of recessed into and grouted flush with slab.

3.4 INSTALLATION - PIPE HANGERS AND SUPPORTS

- A. Install in accordance with ASME B31.1, ASME B31.9, ASTM F708, MSS SP 58, MSS SP 69, and MSS SP 89.
- B. Support horizontal piping as scheduled.
- C. Install hangers with minimum 1/2 inch space between finished covering and adjacent work.
- D. Place hangers within 12 inches of each horizontal elbow.
- E. Use hangers with 1-1/2 inch minimum vertical adjustment.
- F. Support vertical piping at every other floor.
- G. Where piping is installed in parallel and at same elevation, provide multiple pipe or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide sheet lead packing between hanger or support and piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings Refer to Section 23 07 00.
- M. Provide supplemental angles, channels and formed steel supports to support piping, ductwork, equipment, etc. from building's structure. Piping, ductwork, equipment, etc. shall not be supported from the roof deck.

3.5 SCHEDULES

A. Copper and Steel Pipe Hanger Spacing:

PIPE SIZE Inches	COPPER TUBING MAXIMUM HANGER SPACING Feet	STEEL PIPE MAXIMUM HANGER SPACING Feet	COPPER TUBING HANGER ROD DIAMETER Inches	STEEL PIPE HANGER ROD DIAMETER Inches
1/2	5	7	3/8	3/8
3/4	5	7	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	7	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2 (Note 2)	9	11	1/2	1/2
3	10	12	1/2	1/2
4	12	14	1/2	5/8

END OF SECTION 230529



SECTION 230548 VIBRATION CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Intent
  - 1. All mechanical equipment, piping and ductwork as noted on the equipment schedule or in the specification shall be mounted on vibration isolators to prevent the transmission of vibration and mechanically transmitted sound to the building structure. Vibration isolators shall be selected in accordance with the weight distribution so as to produce reasonably uniform deflections.
  - 2. All isolators and isolation materials shall be of the same manufacturer and shall be certified by the manufacturer.
  - 3. This specification is considered to be minimum requirements for seismic consideration as required for life safety.
  - 4. Any variance or non-compliance with these specification requirements shall be corrected by the contractor in an approved manner.
  
- B. The work of this section includes but is not limited to the following:
  - 1. Vibration isolation elements.
  - 2. Equipment isolation bases.
  - 3. Piping flexible connections.
  - 4. Wind restraints as defined by ASCE Chapter 7 – 2010.

1.2 QUALIFICATIONS

- A. Qualifications: Only firms having five years experience designing and manufacturing isolation and restraint devices shall be capable of work in this specification.

1.3 SUBMITTALS

- A. Submit under provisions of Division 1 and Section 23 04 00.
  
- B. The submittal material shall include copies of descriptive data for all products and materials including but not limited to the following:
  - 1. Descriptive Data: Catalog cuts or data sheets.
  
- C. The submittal material shall include copies of descriptive data for all products and materials including but not limited to the following:
  - 1. Descriptive Data: Catalog cuts or data sheets.
  - 2. Shop Drawings:
    - a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.
    - b. Provide Drawings showing methods of suspension and support guides for conduit, piping, ductwork and ceiling hung equipment.
    - c. Drawings showing methods for isolation of conduits, pipes and ductwork penetrating walls and floor slabs.

- d. Drawings shall show housekeeping pad reinforcement and monolithic pad attachment to the structure.
- 3. Wind Certification and Analysis:
  - a. Wind restraint calculations shall be provided for all connections of equipment to the structure. Calculations shall be stamped by a registered professional engineer with at least five years of design experience, licensed in the state of the job location.
  - b. Analysis shall indicate calculated dead loads, wind loads and capacity of materials utilized for connections to equipment and structure. Analysis shall detail anchoring methods, bolt diameter, embedment and/or welded length.

D. Shop Drawings:

- 1. Shop Drawings:
  - a. Submit fabrication details for equipment bases including dimensions, structural member sizes and support point locations.

#### 1.4 CONTRACTOR'S RESPONSIBILITIES

A. Contractor shall have the following responsibilities:

- 1. Provide and install isolation systems and wind restraints as scheduled or specified.
- 2. Guarantee specified isolation system deflection.
- 3. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
- 4. Provide installation instructions, drawings and trained field supervision to insure proper installation and performance.

#### 1.5 RELATED WORK

A. Supplementary Support Steel

- 1. Contractor shall supply supplementary support steel for all equipment, piping, ductwork, etc. including roof mounted equipment, as required or specified.

B. Attachments

- 1. Contractor shall supply restraint attachment plates cast into housekeeping pads, concrete inserts, double sided beam clamps, etc. in accordance with the requirements of the vibration vendor's calculations.

#### 1.6 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of Division 1 and Section 23 04 00.
- B. Record actual locations and installation of vibration isolators and restraints including attachment points.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Mason Industries Inc. models listed below.
- B. Other approved manufacturers providing equivalent products include:
  - 1. Novia Associates. (Seismic Control Products)
  - 2. Vibration Eliminator Co.
  - 3. Pate.
  - 4. Vibro-Acoustics Ltd

### 2.2 PRODUCT DESCRIPTIONS

- A. Vibration Isolators and Seismic Restraint Specifications
  - 1. Specification 1 - Neoprene Pad
    - a. Two layers of 3/4" thick neoprene pad consisting of 2" square waffle modules separated horizontally by a 16 gauge galvanized shim. Load distribution plates shall be used as required.
    - b. Pads shall be Type Super "W" as manufactured by Mason Industries, Inc.
  - 2. Specification 2 - Bridge - Bearing Neoprene Mountings
    - a. Bridge bearing neoprene mountings shall have a minimum static deflection of 0.2" and all directional seismic capability. The mount shall consist of a ductile iron casting containing two separated and opposing molded neoprene elements. The elements shall prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation. The shock absorbing neoprene materials shall be compounded to bridge bearing specifications. Mountings shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
    - b. Mountings shall be Type BR as manufactured by Mason Industries, Inc.
  - 3. Specification 3 – Bushing Assemblies
    - a. Sheet metal panels shall be bolted to the walls or supporting structure by assemblies consisting of a neoprene bushing cushioned between 2 steel sleeves. The outer sleeve prevents the sheet metal from cutting into the neoprene. Enlarge panel holes as required. Neoprene elements pass over the bushing to cushion the back panel horizontally. A steel disc covers the inside neoprene element and the inner steel sleeve is elongated to act as a stop so tightening the anchor bolts does not interfere with panel isolation in 3 planes. Bushing assemblies can be applied to the ends of steel cross members where applicable. All neoprene shall be bridge bearing quality.
    - b. Bushing assemblies shall be type PB as manufactured by Mason Industries, Inc.
  - 4. Specification 4 - Neoprene Bushing
    - a. A one piece molded bridge bearing neoprene washer/bushing. The bushing shall surround the anchor bolt and have a flat washer face to avoid metal to metal contact.

- b. Neoprene bushings shall be type HG as manufactured by Mason Industries, Inc.
- 5. Specification 5 – Spring Isolators
  - a. Spring isolators shall be free standing and laterally stable without any housing and complete with a molded neoprene cup or 1/4" neoprene acoustical friction pad between the baseplate and the support. All mountings shall have leveling bolts that must be rigidly bolted to the equipment. Spring diameters shall be no less than 0.8 of the compressed height of the spring at rated load. Springs shall have a minimum additional travel to solid equal to 50% of the rated deflection. Submittals shall include spring diameters, deflection, compressed spring height and solid spring height.
  - b. Mountings shall be Type SLF as manufactured by Mason Industries, Inc.
- 6. Specification 6 – Restrained Spring Mountings
  - a. Restrained spring mountings shall have an SLF mounting as described in Specification 5, within a rigid housing that includes vertical limit stops to prevent spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action. Limit stops shall be out of contact during normal operation. Since housings will be bolted or welded in position there must be an internal isolation pad. Housing shall be designed to resist all seismic forces. Mountings shall have Anchorage Preapproval "R" Number from OSHPD in the state of California certifying the maximum certified horizontal and vertical load ratings.
  - b. Mountings shall be SLR as manufactured by Mason Industries, Inc.
- 7. Specification 7 – Spring Mountings
  - a. Spring mountings as in specification 5 built into a ductile iron or steel housing to provide all directional seismic snubbing. The snubber shall be adjustable vertically and allow a maximum of 1/4" travel in all directions before contacting the resilient snubbing collars. Mountings shall have an Anchorage Preapproval "R" number from OSHPD in the State of California verifying the maximum certified horizontal and vertical load ratings.
  - b. Mountings shall be SSLFH as manufactured by Mason Industries, Inc.
- 8. Specification 8 – Air Springs
  - a. Air springs shall be manufactured with upper and lower steel sections connected by a replaceable flexible nylon reinforced neoprene element. Air spring configuration shall be multiple bellows to achieve a maximum natural frequency of 3 Hz. Air Springs shall be designed for a burst pressure that is a minimum of three times the published maximum operating pressure. All air spring systems shall be connected to either the building control air or a supplementary air supply and equipped with three leveling valves to maintain leveling within plus or minus 1/8" Submittals shall include natural frequency, load and damping tests performed by an independent lab or acoustician.
  - b. Air Springs shall be Type MT and leveling valves Type LV as manufactured by Mason Industries, Inc.

9. Specification 9 – Restrained Air Springs
  - a. Restrained air spring mountings shall have an MT air spring as described in Specification 8, within a rigid housing that includes vertical limit stops to prevent air spring extension when weight is removed. The housing shall serve as blocking during erection. A steel spacer shall be removed after adjustment. Installed and operating heights are equal. A minimum clearance of 1/2" shall be maintained around restraining bolts and between the housing and the air spring so as not to interfere with the air spring action. Limit stops shall be out of contact during normal operation. Housing shall be designed to resist all seismic forces.
  - b. Mountings shall be SLR-MT as manufactured by Mason Industries, Inc.
10. Specification 10 – Hangers
  - a. Hangers shall consist of rigid steel frames containing minimum 1 1/4" thick neoprene elements at the top and a steel spring with general characteristics as in specification 5 seated in a steel washer reinforced neoprene cup on the bottom. The neoprene element and the cup shall have neoprene bushings projecting through the steel box. To maintain stability the boxes shall not be articulated as clevis hangers nor the neoprene element stacked on top of the spring. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc from side to side before contacting the rod bushing and short circuiting the spring. Submittals shall include a hanger drawing showing the 30° capability.
  - b. Hangers shall be type 30N as manufactured by Mason Industries, Inc.
11. Specification 11 – Hangers
  - a. Hangers shall be as described in 10, but they shall be precompressed and locked at the rated deflection by means of a resilient seismic up-stop to keep the piping or equipment at a fixed elevation during installation. The hangers shall be designed with a release mechanism to free the spring after the installation is complete and the hanger is subjected to its full load. Deflection shall be clearly indicated by means of a scale. Submittals shall include a drawing of the hanger showing the 30° capability.
  - b. Hangers shall be type PC30N as manufactured by Mason Industries, Inc.
12. Specification 12 – Not Used
13. Specification 13 – Not Used
14. Specification 14 – Rod Clamp Assemblies
  - a. Steel angles, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.
  - b. Rod clamp assemblies shall be Type SRC as manufactured by Mason Industries, Inc.
15. Specification 15 – Clevis Hanger Cross Brace
  - a. Pipe clevis cross bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross braces shall have an Anchorage Preapproval "R" Number from OSHPD in the State of California.

- b. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.
- 16. Specification 16 through 19- Not Used
- 17. Specification 17 – Inertia Foundations
- 18. Specification 20 – Flexible Stainless Steel Hoses
  - a. Flexible stainless steel hose shall have stainless steel braid and carbon steel fittings. Sizes 3" and larger shall be flanged. Smaller sizes shall have male nipples. Minimum lengths shall be as tabulated:

<u>Flanged</u>		<u>Male Nipples</u>	
3 x 14	10 x 26	1/2 x 9	1 1/2 x 13
4 x 15	12 x 28	3/4 x 10	2 x 14
5 x 19	14 x 30	1 x 11	2 1/2 x 18
6 x 20	16 x 32	1 1/4 x 12	

- b. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible.
- c. Hoses shall be type BSS as manufactured by Mason Industries, Inc.
- 19. Specification 21 – Roof Curbs
  - a. Curbs shall provide continuous support for the equipment and shall be designed to resist wind and seismic forces. Construction shall be minimum 12 gauge galvanized steel. Provide support angles and cross braces for acoustical panels which shall be installed throughout the entire roof curb. All duct and piping penetrations in the panels shall be sealed with a non hardening caulk. All curbs shall be custom, pitched curbs; pitch shall match the roof steel / roof framing pitch to provide a level surface on top to mount equipment unless noted otherwise. Curb shall be Pate PC-4.

### PART 3 EXECUTION

#### 3.1 GENERAL

- A. Vibration isolators and wind restraint systems shall control excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork, or conduit. The installation of all vibration isolators and wind restraint units, and associated hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.
- B. All vibration isolators and wind restraint systems must be installed in strict accordance with the manufacturers written instructions and all certified submittal data.
- C. Installation of vibration isolators and wind restraints must not cause any change of position of equipment, piping or ductwork resulting in stresses or misalignment.

- D. No rigid connections between equipment and the building structure shall be made that degrades the noise and vibration control system herein specified.
- E. The contractor shall not install any equipment, piping, duct or conduit that makes rigid connections with the building unless isolation is not specified. "Building" includes, but is not limited to, slabs, beams, columns, studs and walls.
- F. Coordinate work with other trades to avoid rigid contact with the building.
- G. Any conflicts with other trades that will result in rigid contact with equipment or piping due to inadequate space or other unforeseen conditions should be brought to the architects/engineers attention prior to installation. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- H. Bring to the architects/engineers attention any discrepancies between the specifications and the field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the responsible contractor's expense.
- I. Overstressing of the building structure must not occur because of overhead support of equipment. Contractor must submit loads to the structural engineer of record for approval. Generally bracing may occur from:
  - 1. Flanges of structural beams.
  - 2. Upper truss cords in bar joist construction.
  - 3. Cast in place inserts or wedge type drill-in concrete anchors.
- J. Restraints and isolators installed outside or other locations exposed to weather shall be constructed of weather proof materials including galvanized steel structural frames, stainless steel threaded rods, stainless steel hardware, etc
- K. Specification 12 cable restraints shall be installed slightly slack to avoid short circuiting the isolated suspended equipment, piping or conduit.
- L. Specification 12 cable assemblies are installed taut on non-isolated systems.
- M. Where piping passes through walls, floors or ceilings the vibration isolation manufacturer shall provide specification 23 wall seals.

### 3.2 VIBRATION ISOLATION RESTRAINT INSTALLATION

- A. **Vibration Isolation of Horizontal Piping:** The first 50' of piping connected to mechanical equipment including air handling units and pumps shall be isolated by hangers as described in specification 10 or 11. All piping in the boiler rooms / mechanical rooms shall be isolated by hangers as described in specification 10 or 11. Brace hanger rods with SRC clamps specification 14. Floor supported piping shall rest on isolators as described in specification 6. Heat exchanger's and expansion tanks are considered part of the piping run. The first three isolators from the isolated equipment will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceilings under occupied



spaces the first three hangers shall have 0.75" (19mm) deflection for pipe sizes up to and including 3" (75mm), 1 1/2" (38mm) deflection for pipe sizes up to and including 6" (150mm), and 2 1/2" (64mm) deflection thereafter. Hangers shall be located as close to the overhead structure as practical.

- B. Vibration Isolation of Piping Risers: Risers shall be suspended from specification 10 hangers or supported by specification 5 mountings, anchored with specification 25 anchors, and guided with specification 26 sliding guides. Steel springs shall be a minimum of 0.75" (19mm) except in those expansion locations where additional deflection is required to limit load changes to  $\pm 25\%$  of the initial load. Submittals must include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on the building structure, spring deflection changes and seismic loads. Submittal data shall include certification that the riser system has been examined for excessive stresses and that none will exist in the proposed design.
- C. Vibration Isolation of Ductwork
1. All discharge runs for a distance of 50' from the connected equipment shall be isolated from the building structure by means of specification 10 hangers or specification 5 floor isolators. Spring deflection shall be a minimum of 0.75".
  2. All duct runs having air velocity of 1000 fpm or more shall be isolated from the building structure by specification 11 hangers or specification 5 floor supports. Spring deflection shall be a minimum of 0.75".
- D. Vibration Isolation of Mechanical Equipment
1. All mechanical equipment shall be vibration isolated.
  2. All floor mounted equipment shall be installed on housekeeping pads. Equipment shall be anchored to pads to meet acceleration criteria. Concrete pads shall be properly doweled or expansion shielded to deck to meet acceleration criteria.
  3. Pumps: All piping connections to pumps shall be made with specification 20.
  4. All mechanical equipment suspended from the building's structure shall be vibration isolated with combinations of Specification 5 thru 17.
  5. All hung equipment shall be installed with specification 10 cables if isolated. Specification 10 or 11 restraints may be used on un-isolated equipment and devices. Hung equipment includes n line fans, VAV boxes, unit heaters, pipe mounted equipment, etc.
  6. Specification 1 – Neoprene Pad: Equipment listed below shall be anchored with this specification.
    - a. Heat Pumps.
  7. Specification 21 - Roof Curbs: Equipment listed below shall be anchored with this specification. Units shall be mounted at minimum 18" above roof to the bottom of the equipment – measurement is to be taken at the point where the curb is at the roof's highest point (pitched roofs). Roof curbs shall be anchored to the roof structure.
    - a. Roof hoods.



3.3 INSPECTION

- A. Examine systems under provisions of Division 1.
- B. On completion of installation of all vibration isolation devices herein specified, the local representative shall inspect the completed system and report in writing any installation error, improperly elected isolation devices, or other faults in the system that could affect the performance of the system. Contractor shall submit a report to the Owner, including the manufacturers representatives' final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

END OF SECTION 230548

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SECTION 230593 TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of air systems.
2. Testing, adjusting, and balancing of hydronic systems.
3. Measurement of final operating condition of HVAC systems.
4. Domestic Hot Water Recirculating
5. Testing and recording of setpoints for BMS.

B. Related Sections:

1. Section 01 91 13 - General Commissioning Requirements.
2. Section 23 04 00 – General Conditions for Mechanical Trades
3. Section 23 09 23 - Direct-Digital Control System for HVAC: Requirements for coordination between DDC system and testing, adjusting, and balancing work.
4. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation for HVAC equipment.

1.2 REFERENCES

A. Associated Air Balance Council:

1. AABC MN-1 - National Standards for Testing and Balancing Heating, Ventilating, and Air Conditioning Systems.

B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:

1. ASHRAE 111 - Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning and Refrigeration Systems.

C. Testing Adjusting and Balancing Bureau

1. TABB- ANSI Accredited HVAC testing, adjusting and balancing certification program which conforms to ISO/IEC 17024 and endorsed by SMACNA.

D. Natural Environmental Balancing Bureau:

1. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.

1.3 SUBMITTALS

A. Section 01 33 00 - Submittal Procedures: Submittal procedures.

B. Prior to commencing Work, submit proof of latest calibration date of each instrument.

C. Test Reports: Indicate data on AABC MN-1 National Standards for Total System Balance forms or NEBB Report forms containing information indicated in Schedules.

- D. Field Reports:
    - 1. Indicate deficiencies preventing proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
    - 2. Indicate suspected general deficiencies, even if not affected by testing and balancing.
  - E. Prior to commencing Work, submit report forms or outlines indicating adjusting, balancing, and equipment data required. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty and/or Copy of NEBB Certificate of Conformance Certification.
  - F. Submit draft copies of report for review prior to final acceptance of Project.
  - G. Furnish reports in binder manuals, complete with table of contents page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- 1.4 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Project Record Documents: Record actual locations of flow measuring stations balancing valves and rough setting.
  - C. Operation and Maintenance Data: Furnish final copy of testing, adjusting, and balancing report inclusion in operating and maintenance manuals.
- 1.5 QUALITY ASSURANCE
- A. Perform Work in accordance with AABC MN-1 National Standards for Field Measurement and Instrumentation, Total System Balance NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.
  - B. Maintain one copy of each document on site.
  - C. Prior to commencing Work, calibrate each instrument to be used. Upon completing Work, recalibrate each instrument to assure reliability.
- 1.6 QUALIFICATIONS
- A. Agency: Company specializing in testing, adjusting, and balancing of systems specified in this section with minimum three years documented experience certified by AABC, TABB, or NEBB.
  - B. Perform Work under supervision of AABC, TABB or NEBB Certified Engineer or Supervisor.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 SEQUENCING

- A. Section 01 10 00 - Summary: Work sequence.
- B. Sequence balancing between completion of systems tested and Date of Substantial Completion.

1.9 SCHEDULING

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify systems are complete and operable before commencing work. Verify the following:
  - 1. Systems are started and operating in safe and normal condition.
  - 2. Temperature control systems are installed complete and operable.
  - 3. Proper thermal overload protection is in place for electrical equipment.
  - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - 5. Duct systems are clean of debris.
  - 6. Fans are rotating correctly.
  - 7. Fire and volume dampers are in place and open.
  - 8. Air coil fins are cleaned and combed.
  - 9. Access doors are closed and duct end caps are in place.
  - 10. Air outlets are installed and connected.
  - 11. Duct system leakage is minimized.
  - 12. Hydronic systems are flushed, filled, and vented.
  - 13. Pumps are rotating correctly.
  - 14. Proper strainer baskets are clean and in place or in normal position.
  - 15. Service and balancing valves are open.

3.2 PREPARATION

- A. Furnish instruments required for testing, adjusting, and balancing operations.
- B. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.3 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 10 percent of design.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.4 RECORDING OF SETPOINTS

- A. Measure and record operating setpoints for Building Management System (BMS) contractor to record and save as operating parameters in the BMS software. Refer to Specification Section 23 09 93 - Sequence of Operations for HVAC Controls.

3.5 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Testing, adjusting, and balancing.
- B. Verify recorded data represents actual measured or observed conditions.
- C. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- D. After adjustment, take measurements to verify balance has not been disrupted. If disrupted, verify correcting adjustments have been made.
- E. Report defects and deficiencies noted during performance of services, preventing system balance.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- G. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by Owner.
- H. Check and adjust systems approximately six months after final acceptance and submit report.

3.6 AC UNIT - PROCEDURE

- A. Measure air temperature inlet and outlet under full cooling mode to verify operation.

3.7 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to obtain required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in main ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts.
- E. Use volume control devices to regulate air quantities only to extent adjustments do not create objectionable air motion or sound levels. Effect volume control by using volume dampers located in ducts.
- F. Vary total system air quantities by adjustment of fan speeds. Provide sheave drive changes to vary fan speed (cost for material and labor shall be carried in the project). Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. At air handling units and air supply units, prepare system pressure profiles across all sections of the unit including mixing box, filters, coils and total pressure across fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. At modulating damper locations, take measurements and balance at extreme conditions.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to obtain required relationship between each to maintain approximately 0.05 inches positive static pressure near building entries.
- M. Balance variable volume systems at maximum airflow rate and at minimum airflow rate. Measure and record static pressure at duct mounted supply air static pressure controller(s).

3.8 WATER SYSTEM PROCEDURE

- A. Adjust water systems, after air balancing, to obtain design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow-metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in system.
- C. Adjust systems to obtain specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open or in normal position to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Measure and record inlet and outlet temperatures at heat transfer elements and cooling and heating plants at full cooling and heating capacity.
- G. Radiant Floor Heating System: Balance total system flow and flow to each circuit.
- H. Where available pump capacity is less than total flow requirements or individual system parts, simulate full flow in one part by temporary restriction of flow to other parts.

3.9 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
  - 1. HVAC Pumps.
  - 2. Air Moving Equipment.
  - 3. Terminal Heat Transfer Units.
  - 4. Air Handling Units.
  - 5. Garage Air Handling Unit.
  - 6. Trombe Wall RA Flow Rates.
  - 7. Fans.
  - 8. Energy Recovery Equipment
  - 9. Air Coils.
  - 10. Air Filters.
  - 11. Air Terminal Units.
  - 12. Air Inlets and Outlets.
  - 13. Water Coils.
  - 14. Fuel Fired Equipment.
  - 15. Domestic Water Heat Exchanger.
  - 16. Plumbing Pumps and Distribution.
  - 17. Water to Water Heat Pumps.



B. Report Forms

1. Title Page:
  - a. Name of Testing, Adjusting, and Balancing Agency
  - b. Address of Testing, Adjusting, and Balancing Agency
  - c. Telephone and facsimile numbers of Testing, Adjusting, and Balancing Agency
  - d. Project name
  - e. Project location
  - f. Project Architect
  - g. Project Engineer
  - h. Project Contractor
  - i. Project altitude
  - j. Report date
2. Summary Comments:
  - a. Design versus final performance
  - b. Notable characteristics of system
  - c. Description of systems operation sequence
  - d. Summary of outdoor and exhaust flows to indicate building pressurization
  - e. Nomenclature used throughout report
  - f. Test conditions
3. Instrument List:
  - a. Instrument
  - b. Manufacturer
  - c. Model number
  - d. Serial number
  - e. Range
  - f. Calibration date
4. Electric Motors:
  - a. Manufacturer
  - b. Model/Frame
  - c. HP/BHP and kW
  - d. Phase, voltage, amperage; nameplate, actual, no load
  - e. RPM
  - f. Service factor
  - g. Starter size, rating, heater elements
  - h. Sheave Make/Size/Bore
5. V-Belt Drive:
  - a. Identification/location
  - b. Required driven RPM
  - c. Driven sheave, diameter and RPM
  - d. Belt, size and quantity
  - e. Motor sheave diameter and RPM
  - f. Center to center distance, maximum, minimum, and actual

6. Pump Data:
  - a. Identification/number
  - b. Manufacturer
  - c. Size/model
  - d. Impeller
  - e. Service
  - f. Design flow rate, pressure drop, BHP and kW
  - g. Actual flow rate, pressure drop, BHP and kW
  - h. Discharge pressure
  - i. Suction pressure
  - j. Total operating head pressure
  - k. Shut off, discharge and suction pressures
  - l. Shut off, total head pressure
7. Cooling Coil Data:
  - a. Identification/number
  - b. Location
  - c. Service
  - d. Manufacturer
  - e. Air flow, design and actual
  - f. Entering air DB temperature, design and actual
  - g. Entering air WB temperature, design and actual
  - h. Leaving air DB temperature, design and actual
  - i. Leaving air WB temperature, design and actual
  - j. Water flow, design and actual
  - k. Water pressure drop, design and actual
  - l. Entering water temperature, design and actual
  - m. Leaving water temperature, design and actual
  - n. Saturated suction temperature, design and actual
  - o. Air pressure drop, design and actual
8. Heating Coil Data:
  - a. Identification/number
  - b. Location
  - c. Service
  - d. Manufacturer
  - e. Air flow, design and actual
  - f. Water flow, design and actual
  - g. Water pressure drop, design and actual
  - h. Entering water temperature, design and actual
  - i. Leaving water temperature, design and actual
  - j. Entering air temperature, design and actual
  - k. Leaving air temperature, design and actual
  - l. Air pressure drop, design and actual
9. Hydronic Heating Units:
  - a. Identification/number
  - b. Location
  - c. Service
  - d. Manufacturer
  - e. Water flow, design and actual
  - f. Entering water temperature, design and actual

- g. Leaving water temperature, design and actual
- h. For unit heaters and cabinet unit heaters:
  - 1) Entering air temperature, design and actual
  - 2) Leaving air temperature, design and actual
- 10. Plumbing Fixtures:
  - a. Identification/number
  - b. Location
  - c. Service
  - d. Manufacturer
  - e. Balance data at hot water recirculating bypasses.
  - f. Fixture hot water outlet temperature.
  - g. Time for hot water temperature to be established.
- 11. Air Moving Equipment:
  - a. Location
  - b. Manufacturer
  - c. Model number
  - d. Serial number
  - e. Arrangement/Class/Discharge
  - f. Air flow, specified and actual
  - g. Return air flow, specified and actual
  - h. Outside air flow, specified and actual
  - i. Total static pressure (total external), specified and actual
  - j. Inlet pressure
  - k. Discharge pressure
  - l. Sheave Make/Size/Bore
  - m. Number of Belts/Make/Size
  - n. Fan RPM
- 12. Return Air/Outside Air Data:
  - a. Identification/location
  - b. Design air flow
  - c. Actual air flow
  - d. Design return air flow
  - e. Actual return air flow
  - f. Design outside air flow
  - g. Actual outside air flow
  - h. Return air temperature
  - i. Outside air temperature
  - j. Required mixed air temperature
  - k. Actual mixed air temperature
  - l. Design outside/return air ratio
  - m. Actual outside/return air ratio
- 13. Exhaust Fan Data:
  - a. Location
  - b. Manufacturer
  - c. Model number
  - d. Serial number
  - e. Air flow, specified and actual
  - f. Total static pressure (total external), specified and actual
  - g. Inlet pressure

- h. Discharge pressure
- i. Sheave Make/Size/Bore
- j. Number of Belts/Make/Size
- k. Fan RPM
- 14. Duct Traverse:
  - a. System zone/branch
  - b. Duct size
  - c. Area
  - d. Design velocity
  - e. Design air flow
  - f. Test velocity
  - g. Test air flow
  - h. Duct static pressure
  - i. Air temperature
  - j. Air correction factor
- 15. Energy Recovery Equipment:
  - a. Identification/number
  - b. Location
  - c. Service
  - d. Manufacturer
  - e. Air flows, design and actual
  - f. Entering air temperature, design and actual; dry bulb and wet bulb
  - g. Leaving air temperature, design and actual; dry bulb and wet bulb
  - h. Air pressure drop, design and actual
- 16. Air Monitoring Station Data:
  - a. Identification/location
  - b. System
  - c. Size
  - d. Area
  - e. Design velocity
  - f. Design air flow
  - g. Test velocity
  - h. Test air flow
- 17. Flow Measuring Station and Flow Meters:
  - a. Identification/number
  - b. Location
  - c. Size
  - d. Manufacturer
  - e. Model number
  - f. Serial number
  - g. Design Flow rate
  - h. Design pressure drop
  - i. Actual/final pressure drop
  - j. Actual/final flow rate
  - k. Station calibrated setting

18. Terminal Unit Data:
  - a. Manufacturer
  - b. Type, constant, variable, single, dual duct
  - c. Identification/number
  - d. Location
  - e. Model number
  - f. Size
  - g. Minimum static pressure
  - h. Minimum design air flow
  - i. Maximum design air flow
  - j. Maximum actual air flow
  - k. Inlet static pressure
19. Air Distribution Test Sheet:
  - a. Air terminal number
  - b. Room number/location
  - c. Terminal type
  - d. Terminal size
  - e. Area factor
  - f. Design velocity
  - g. Design air flow
  - h. Test (final) velocity
  - i. Test (final) air flow
  - j. Percent of design air flow
20. AC Unit:
  - a. Location
  - b. Serial number
  - c. Entering and leaving DB air temperature, design and actual
21. Water to Water Heat Pumps
  - a. Capacity
  - b. Serial number
  - c. Evaporator entering water temperature, design and actual
  - d. Evaporator leaving water temperature, design and actual
  - e. Evaporator pressure drop, design and actual
  - f. Evaporator water flow rate, design and actual
  - g. Condenser entering water temperature, design and actual
  - h. Condenser leaving water temperature, design and actual
  - i. Condenser pressure drop, design and actual
  - j. Condenser water flow rate, design and actual

3.10 POST OCCUPANCY BALANCING

- A. Contractor shall perform (2) additional site visits after spaces have been occupied to rebalance systems as direct by the Owner or Engineer. These site visits shall encompass changes as directed by the Owner and shall not encompass changes or modifications made by the contractor which have resulted in the need to rebalance systems. Each site visit shall be a duration of four hours and shall include balancing of air and/or water systems.

END OF SECTION 230593

## SECTION 230700 HVAC INSULATION

### PART 1 GENERAL

#### 1.1 SUMMARY

A. Section Includes:

1. HVAC piping insulation, jackets and accessories.
2. HVAC equipment insulation, jackets and accessories.
3. HVAC ductwork insulation, jackets, and accessories.
4. HVAC acoustical duct wrap.

B. Related Sections:

1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 09 90 00 - Painting and Coating: Execution requirements for painting insulation jackets and covering specified by this section.
3. Section 23 04 00 – General Conditions for Mechanical Trades

#### 1.2 REFERENCES

A. International Energy Conservation Code.

B. ASTM International:

1. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
2. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
3. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
4. ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.
5. ASTM C449/C449M - Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.
6. ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.
7. ASTM C534 - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
8. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.
9. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
10. ASTM C585 - Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).
11. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
12. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

13. ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.
  14. ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).
  15. ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.
  16. ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.
  17. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  18. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials.
  19. ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.
- C. Sheet Metal and Air Conditioning Contractors' National Association':
1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- D. Underwriters Laboratories Inc.:
1. UL 1978 - Standard for Safety for Grease Ducts.

### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.
- C. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

### 1.4 QUALITY ASSURANCE

- A. As a minimum requirement, all products and installation methods shall comply with 2012 International Energy Conservation Code.
- B. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding 50 in accordance with ASTM E84.
- C. Pipe insulation manufactured in accordance with ASTM C585 for inner and outer diameters.
- D. Factory fabricated fitting covers manufactured in accordance with ASTM C450.
- E. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.



- F. All insulating materials shall be free of asbestos.
- G. All insulating products and coverings shall be UL listed.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Applicator: Company specializing in performing Work of this section with minimum three years documented experience as approved by manufacturer.

#### 1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.

#### 1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements: Environmental conditions affecting products on site.
- B. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
- C. Maintain temperature before, during, and after installation for minimum period of 24 hours.

#### 1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Manufacturers for Glass Fiber and Mineral Fiber Insulation Products:
  - 1. CertainTeed.
  - 2. Knauf.
  - 3. Johns Manville.
  - 4. Owens-Corning.
- B. Manufacturers for Closed Cell Elastomeric Insulation Products:
  - 1. Aeroflex. Aerocel.
  - 2. Armacell, LLC. Armaflex.
  - 3. Nomaco. K-flex.
- C. Manufacturers for Adhesives and Sealers:
  - 1. Benjamin Foster (H.B. fuller Co.)
  - 2. Rubatex.
  - 3. Minnesota Mining and Mfg Co. (3M)

### 2.2 PIPE INSULATION

- A. TYPE P-1: ASTM C547, molded glass fiber pipe insulation.
  - 1. Thermal Conductivity: 0.23 at 75 degrees F.
  - 2. Operating Temperature Range: 0 to 850 degrees F.
  - 3. Vapor Barrier Jacket: ASTM C1136, Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.
  - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- B. TYPE P-2: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
  - 1. Thermal Conductivity: 0.27 at 75 degrees F.
  - 2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

### 2.3 PIPE INSULATION JACKETS

- A. PVC Plastic Pipe Jacket:
  - 1. Product Description: ASTM D1785, one piece molded type fitting covers and sheet material, off-white color.
  - 2. Thickness: 10 mil.
  - 3. Connections: Brush on welding adhesive; vapor retardant with pressure sensitive color matching vinyl tape.
  - 4. Fittings and Valves: provide factory precut inserts.
  - 5. For exterior locations, PVC jacket shall be UV resistant.

- B. Aluminum Pipe Jacket:
  - 1. ASTM B209.
  - 2. Thickness: 0.020 inch thick sheet.
  - 3. Finish: Smooth.
  - 4. Joining: Longitudinal slip joints and 2 inch laps.
  - 5. Fittings: Minimum 0.016 inch thick die shaped fitting covers with factory attached protective liner.
  - 6. Metal Jacket Bands: Minimum 3/8 inch wide; 0.02inch thick aluminum.

#### 2.4 PIPE INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
- B. Covering Adhesive Mastic: Compatible with insulation.
- C. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
- D. Piping 2 inches diameter and larger: Insulation saddle. Insert length: not less than 6 inches long, matching thickness and contour of adjoining insulation.
- E. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with aluminum jacket single piece construction with self-adhesive closure. Thickness to match pipe insulation.
- F. Insulating Cement: ASTM C195; hydraulic setting on mineral wool.
- G. Adhesives: Compatible with insulation.

#### 2.5 EQUIPMENT INSULATION

- A. TYPE E-1: ASTM C553; glass fiber, flexible or semi-rigid, noncombustible.
  - 1. Thermal Conductivity: 0.24 at 75 degrees F.
  - 2. Operating Temperature Range: 0 to 450 degrees F.
  - 3. Density: 1.65 pound per cubic foot.
- B. TYPE E-2: ASTM C612; glass fiber, rigid board, noncombustible with factory applied reinforced aluminum foil jacket.
  - 1. Thermal Conductivity: 0.24 at 75 degrees F.
  - 2. Operating Temperature Range: 0 to 450 degrees F.
  - 3. Density: 3.0 pound per cubic foot.
  - 4. Jacket Temperature Limit: minus 20 to 150 degrees F.
- C. TYPE E-3: ASTM C534, Type I, flexible, closed cell elastomeric insulation, tubular.
  - 1. Thermal Conductivity: 0.27 at 75 degrees F.
  - 2. Operating Temperature Range: Range: Minus 70 to 220 degrees F.

## 2.6 EQUIPMENT INSULATION JACKETS

- A. PVC Plastic Equipment Jacket:
  - 1. Product Description: ASTM D1785, sheet material, off-white color.
  - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.
  - 3. Thickness: 20 mil.
  - 4. Connections: Brush on welding adhesive with tacks.
  
- B. Aluminum Equipment Jacket:
  - 1. ASTM B209 Thickness: 0.032 inch thick sheet.
  - 2. Finish: Smooth.
  - 3. Joining: Longitudinal slip joints and 2 inch laps.
  - 4. Fittings: 0.016 thick die shaped fitting covers with factory attached protective liner.
  - 5. Metal Jacket Bands: 3/8 inch wide; 0.010 inch thick stainless steel.
  
- C. Vapor Retarder Jacket:
  - 1. ASTM C921, white Kraft paper with glass fiber yarn, bonded to aluminized film.
  - 2. Water Vapor Permeance: ASTM E96/E96M; 0.02 perms.

## 2.7 EQUIPMENT INSULATION ACCESSORIES

- A. Vapor Retarder Lap Adhesive: Compatible with insulation.
  
- B. Covering Adhesive Mastic: Compatible with insulation.
  
- C. Adhesives: Compatible with insulation.

## 2.8 DUCTWORK INSULATION

- A. TYPE D-1: ASTM C1290, Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136, Type II.
  - 1. Thermal Conductivity: 0.27 at 75 degrees F.
  - 2. Maximum Operating Temperature: 250 degrees F.
  - 3. Density: 1.0 pound per cubic foot.
  
- B. TYPE D-2: ASTM C612, Type IA or IB, rigid glass fiber, with factory applied reinforced aluminum foil facing meeting ASTM C1136, Type II.
  - 1. Thermal Conductivity: 0.23 at 75 degrees F.
  - 2. Density: 6.0 pound per cubic foot.
  
- C. TYPE D-3: ASTM C1071, ASTM, 1104 Type I, flexible, glass fiber duct liner with coated air side, Johns Manville Linacoustic RC or approved equal.
  - 1. Thermal Conductivity: 0.24 at 75 degrees F.
  - 2. Maximum Operating Temperature: 250 degrees F.
  - 3. Maximum Air Velocity: 6,000 feet per minute.
  - 4. Adhesive: Waterproof, ASTM E162 fire-retardant type.
  - 5. Liner Fasteners: Galvanized steel mechanical fasteners
  - 6. Coating: Polymer based.

- 7. Round duct liner shall be Johns Manville Spiracoustics Plus or approved equal
- D. TYPES D-4 and D-5: Not Used.
- E. TYPE D-6: "Acoustical Duct Wrap" flexible, mass loaded vinyl laminated to fiberglass.
  - 1. Manufacturers: Sound Seal "B-20 LAG/QFA-9, Great Lakes Textiles, Inc." or approved equal.
  - 2. Thickness: 2".
  - 3. Density: 2.0 lb/sf ft.

## 2.9 DUCTWORK INSULATION ACCESSORIES

- A. Vapor Retarder Tape: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.
- B. Vapor Retarder Lap Adhesive: Compatible with insulation.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
- D. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
- E. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
- F. Adhesives: Compatible with insulation.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify piping, equipment and ductwork has been tested before applying insulation materials.
- C. Verify surfaces are clean and dry, with foreign material removed.

### 3.2 INSTALLATION - GENERAL

- A. PVC piping covers for piping, equipment, etc. shall not be installed in spaces defined as plenums used for conveying air; such as ductwork plenums or return air ceiling plenums.

### 3.3 INSTALLATION - PIPING SYSTEMS

- A. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Division 7 for penetrations of assemblies with fire resistance rating greater than one hour.
- B. Multiple layers: Where multiple layers of glass fiber pipe insulation are required, inner layer shall not be provided with vapor barrier jacket.
- C. Piping Systems Conveying Fluids Below Ambient Temperature:
  - 1. Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, air separators and expansion joints.
  - 2. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
  - 3. Insulate fittings, joints, flanges, unions and valves with molded insulation of like material and thickness as adjacent pipe. Finish with PVC fitting covers.
  - 4. Coil Termination Point: Insulate piping and associated components up to coil connection.
- D. Piping Systems Conveying Fluids Above Ambient Temperature:
  - 1. Insulate all parts of system not requiring routine maintenance including: Fittings, valves, strainers and air separators.
  - 2. Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.
  - 3. Insulate fittings, joints, flanges, unions and valves with molded insulation of like material and thickness as adjacent pipe. Finish with PVC fitting covers.
  - 4. Coil Termination Point: For piping over 1" diameter, insulate piping and associated components up to coil connection. For piping 1" and smaller, terminate hot water piping at union connection to coil.
- E. Inserts and Shields:
  - 1. Piping 1-1/2 inches Diameter and Smaller: Install galvanized steel shield between pipe hanger and insulation.
  - 2. Piping 2 inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.
    - a. Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.
    - b. Insert Material: Compression resistant insulating material suitable for planned temperature range and service.
  - 3. Piping Supported by Roller Type Pipe Hangers: Install galvanized steel shield between roller and inserts.

- F. Closed Cell Elastomeric Insulation:
    - 1. Push insulation on to piping.
    - 2. Miter joints at elbows.
    - 3. Seal seams and butt joints with manufacturer's recommended adhesive.
    - 4. When application requires multiple layers, apply with joints staggered.
    - 5. Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.
  
  - G. Piping Exposed to View in Finished Spaces: Finish all with PVC jacket and fitting covers. Prepare for finish painting; Refer to Division 9.
  
  - H. Pipe Elbows Exposed in Mechanical Equipment Rooms and Air Handling Rooms (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- 3.4 INSTALLATION - EQUIPMENT
- A. Exposed Equipment: Locate insulation and cover seams in least visible locations.
  
  - B. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface.
  
  - C. Multiple layers: Where multiple layers of glass fiber insulation are required, inner layer shall not be provided with vapor barrier jacket.
  
  - D. Equipment Containing Fluids Below Ambient Temperature:
    - 1. Insulate entire equipment surfaces.
    - 2. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
    - 3. Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.
    - 4. Finish insulation at supports, protrusions, and interruptions.
  
  - E. Equipment Containing Fluids Above Ambient Temperature:
    - 1. Do not insulate flanges and unions, but bevel and seal ends of insulation.
    - 2. Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.
    - 3. Finish insulation at supports, protrusions, and interruptions.
  
  - F. Equipment in Mechanical Equipment Rooms or Finished Spaces including buffer tanks and air separators: Finish with PVC jacket.
  
  - G. Chilled water pump impellers and suction diffusers: Insulate in two sections for ease of removal. Enclose insulation in galvanized sheet metal box constructed of two sections with gasketed flanges for ease of removal.

- H. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
  - I. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.
  - J. Prepare equipment insulation for finish painting. Refer to Section 09 90 00.
- 3.5 INSTALLATION - DUCTWORK SYSTEMS
- A. Duct dimensions indicated on Drawings are finished inside dimensions.
  - B. For all ductwork located within the building envelope, insulation shall be rated at a minimum installed value of R6. For all ductwork located outside the building envelope, insulation shall be rated at a minimum installed value of R8.
  - C. Insulated ductwork conveying air below ambient temperature:
    - 1. Provide insulation with vapor retarder jackets.
    - 2. Finish with tape and vapor retarder jacket.
    - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
    - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
  - D. Insulated ductwork conveying air above ambient temperature:
    - 1. Provide with or without standard vapor retarder jacket.
    - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
  - E. External Glass Fiber Duct Insulation:
    - 1. Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.
    - 2. Secure insulation without vapor retarder with staples, tape, or wires.
    - 3. Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.
    - 4. Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.
    - 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
  - F. Duct and Plenum Liner:
    - 1. Adhere insulation with adhesive for 100 percent coverage.
    - 2. Secure insulation with mechanical liner fasteners. Comply with SMACNA Standards for spacing.
    - 3. Seal and smooth joints. Seal and coat transverse joints.
    - 4. Seal liner surface penetrations with adhesive.
    - 5. Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.



3.6 SCHEDULES

A. Cooling Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Chilled Water Supply and Return Piping unless noted otherwise	P-1	1-1/4 inch and smaller	0.5
		1-1/2 inch and larger	1.0
Chilled Water Supply and Return Piping in Unconditioned Spaces (i.e. Mechanical Rooms)	P-1	1-1/4 inch and smaller	1.0
		1-1/2 inch and larger	1.5
Condensate Piping from Cooling Coils (Copper Piping)	P-1	All sizes	0.75
Non Potable Cold Water Piping	P-1	All sizes	1.0

B. Heating Services Piping Insulation Schedule:

PIPING SYSTEM	INSULATION TYPE	PIPE SIZE	INSULATION THICKNESS inches
Heating Water Supply and Return unless noted otherwise	P-1	1-1/4 inches and smaller	1.5
		1-1/2 inches and larger	2.0
Heating Water Supply and Return in Partitions in Conditioned Spaces	P-1	1-1/4 inches and smaller	1.0

C. Equipment Insulation Schedule:

EQUIPMENT	INSULATION TYPE	INSULATION THICKNESS inches
Chilled Water Air Separators	E-3	1.5
Chilled Water pump impellers and suction diffusers Each shall be constructed of two sections for ease of removal	E-2	2.0
Chilled Water Buffer Tank	E-3	1.5

Chilled Water - Misc. pipe mounted devices	E-3	1.0
Buffer Tank BT-A	E-3	1.5
Heating Water - Air Separators and other misc. pipe mounted devices	E-2	2.0
Hot Water Buffer Tank	E-2	2.0

D. Ductwork Insulation Schedule:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Outside Air Intake Ducts and Plenums Unless Noted Otherwise	D-1	2.0 / Min R6
Outside Air Intake Ducts and Plenums In Lower Level Mechanical Room	D-2	2.0 / Min R6
Exhaust Air Plenums and Ductwork between louver (exterior envelope penetration) and motorized damper unless noted otherwise.	D-1	2.0 / Min R6
Exhaust Air Plenums and Ductwork In Lower Level Mechanical Room between louver (exterior envelope penetration) and motorized damper	D-2	2.0 / Min R6
Supply Air Ducts and Plenums Unless Note Otherwise	D-1	2.0 / Min R6
Supply Air Ducts and Plenums In Lower Level Mechanical Room.	D-2	2.0 / Min R6
Supply Ducts installed in fully conditioned spaces and exposed below ceilings shall be double wall construction.	N/A	N/A
Return Ducts In Mezzanine Mechanical Room	D-1	1.0
Return Ducts In Lower Level Mechanical Room	D-2	1.0

E. Ductwork Insulation Schedule – Acoustical Treatment:

DUCTWORK SYSTEM	INSULATION TYPE	INSULATION THICKNESS inches
Transfer Air Ducts	D-3	1.0
All Air Handling Units Served by Duct Mounted Sound Attenuators: At SA and RA ductwork from ductwork connection at unit to sound attenuator serving the unit	D-3 and D-6	D-3: 1.0 D-6: 2.0

Definitions:

Concealed spaces shall be defined as locations where ductwork is installed in soffits, ceiling plenums, shafts, etc

END OF SECTION 230700

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SECTION 230923 DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Control equipment.
  - 2. Software.
  - 3. Sensors and input devices.
  - 4. Dampers, valves, actuators and output devices.
  - 5. Variable frequency drives.
  - 6. Copper tubing and gauges.
  - 7. Dashboard screen / monitor.
  - 8. Trending, recording and displaying data.
  - 9. Alarm notifications.
  - 10. Post construction monitoring.
  
- B. Related Sections:
  - 1. Section 01 91 13 – General Commissioning Requirements
  - 2. Section 23 04 00 – General Conditions for Mechanical Trades
  - 3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation implemented using products specified in this section.
  - 4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI MC85.1 - Terminology for Automatic Control.

1.3 OVERVIEW

- A. This specification defines the minimum equipment and performance requirements for a Direct Digital Control (DDC) Building Management System (BMS).
  
- B. It shall be understood that the drawings and specifications describe the approximate locations of the work. Do not scale the drawings to determine exact positions and clearances. Obtain from Architect, Engineer or the Owner any dimensions not shown.
  
- C. Details of construction and of workmanship where not specifically described herein or indicated on the drawings shall be subject to the Engineer's or Owner's approval. It is the intent of these specifications to provide complete systems, left in good working order, ready for operation, including necessary labor and materials, whether or not specifically shown on the drawings or mentioned herein.

- D. Before submitting proposals, examine the specifications and all drawings relating to the work and become fully informed as to the extent and character of the work and the relation of the work to that of other Sections. Examine the drawings of other Sections to become familiar with all the problems and details of the building construction and to note conditions, which affect the work.

#### 1.4 DESCRIPTION OF WORK

- A. System shall be BACnet-compatible in accordance with ASHRAE 135.
- B. Systems described herein are all field installed sensors and devices. Factory installed devices are acceptable providing the DDC Building Management System is the same company as the manufacturer of the HVAC equipment.
- C. Systems shall not require licensing.
- D. BMS shall operate from a new operator's workstation located in the building and shall be based on a distributed control system in accordance with this specification for all mechanical systems. The system shall be complete in all respects, including all labor, control accessories, hardware, software, and peripheral devices necessary to execute the sequence of operations.
- E. The operator's workstation, shall be capable of communicating with devices using the protocols and network standards as defined by ANSI/ASHRAE Standard 135-2001, BACnet.
- F. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and master building controllers. All materials and equipment used shall be standard components, regularly manufactured and not custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.
- G. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and shall not be custom designed especially for this project. All components shall have been thoroughly tested and proven in actual use.
- H. The BMS shall possess a modular architecture, permitting expansion through the addition of more Direct Digital Control Panels (DDCP's), Application Specific Controllers (ASC's), Terminal Equipment Controllers, sensors, actuators, and/or operator terminals.
- I. Provide full DDC control of all HVAC equipment, as indicated per the sequence of operations and the input/output summary.
- J. The Controls System Operator Workstation software shall be graphically oriented and shall be designed and implemented for use on the Internet and the Owner's Intranet. All aspects of the Controls Systems Operator Interface shall be provided to operate through an IT industry standard Web Browsers such as Internet Explorer or Netscape or approved equivalent. The Web Browser based Operator Interface provided shall not require the

procurement or licensing of any special or proprietary software from the Controls Contractor or its suppliers for the Controls Systems OWS.

## 1.5 WIRING

- A. Installation of the entire building management system shall be by skilled electricians and mechanics, all of who are properly licensed, trained and qualified for this work.
- B. All control and interlock wiring shall comply with the national and local electrical codes and Division 26 of these specifications.
- C. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
- D. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
- E. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.
- F. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g. relays and transformers).
- G. Where class 2 wiring is run exposed, wiring shall be run parallel along a surface or perpendicular to it, and bundled, using approved wire ties at no greater than 10 ft intervals. Such bundled cable shall be fastened to the structure, using specified fasteners, at 5 ft intervals or more often to achieve a neat and workmanlike result.
- H. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.
- I. All wiring shall be installed as continuous lengths, where possible. Any required splices shall be made only within an approved junction box or other approved protective device.
- J. Follow manufacturer's installation recommendations for all communication and network cabling. Network or communication cabling shall be run separately from other wiring.
- K. Supervision and checkout of the system shall be by local branch engineers and technicians directly employed by the Control contractor.
- L. Power wiring for the DDCP's, ASC's, and TEC's, shall be provided by the BMS contractor from the nearest power panel for this purpose.
- M. Electrical wiring shall be performed by qualified electricians directly subcontracted by the BMS contractor.

1.6 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Drawings shall be submitted on 11 X 17 ANSI B and be available on electronic format. ROM.
  - 1. Nomenclature of fans, pumps, etc shall match nomenclature on the contract documents.
  - 2. Valve Schedule showing part number, description, configuration, actuator type, body and disc composition, pressure drop, and GPM.
  - 3. Damper Schedule showing dimensions, opposed or parallel, function, and actuator type.
  - 4. Schematic of each air handling system, hydronic system, etc., locating each control component on its respective unit with proper termination point identifiers (include legend). One schematic shall be included for each individual air handling system.
  - 5. Each schematic shall show a chart detailing all hardware components used. The chart shall include:
    - a. Schematic Control Symbol
    - b. Quantity
    - c. Manufacturer's Part Number
    - d. Technical Sheet Reference
    - e. Description of Part
  - 6. Each Direct Digital Control Panel (DDCP) shall be detailed in the submittal to identify termination boards within each panel and termination of their respective field points. Each termination point shall define the point name and point description by each terminal within the field panel. Point names and descriptors shall be consistent throughout the submittal on schematics, wiring diagrams, equipment lists, etc.
  - 7. The Control manufacturer's technical reference sheets for each hardware component and application program shall be included in the submittal.
- C. Shop Drawings: Indicate the following:
  - 1. Trunk cable schematic showing programmable control-unit locations and trunk data conductors.
  - 2. Connected data points, including connected control unit and input device.
  - 3. System graphic displays showing monitored systems, data (connected and calculated) point addresses, and operator notations. Submit demonstration CD or web-link containing graphics.
  - 4. System configuration with peripheral devices, batteries, power supplies, diagrams, modems, and interconnections.
  - 5. Description and sequence of operation for operating, user, and application software.
  - 6. Use terminology in submittals conforming to ASME MC85.1.
  - 7. Coordinate submittals with information requested in Section 23 09 93.
- D. Points List: Provide a separate list of all system points. This list shall be used for sign-off by BMS contractor that each point is connected, programmed, functioning properly and mapped correctly to associated BMS graphics.



- E. Product Data: Submit data for each system component and software module.
- F. Manufacturer's Installation Instructions: Submit installation instruction for each control system component.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Samples:
  - 1. Provide (1) sample of each type of space temperature sensor, humidity sensor and carbon dioxide sensor for review by Owner.
  - 2. Provide listing of all rooms where all space sensors are to be installed; indicating the type of sensor to be installed in each room for review by Owner.

#### 1.7 QUALITY ASSURANCE

- A. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards.
- B. Provide written approvals and certifications after installation has been completed.
- C. Manufacturer must prove that he has been engaged in the production, installation and service of this type of equipment for at least five (5) years and has a fully equipped; factory trained and authorized service organization.
- D. The system control contractor shall have been an authorized installing contractor for the manufacturer's components for a minimum of (5) years.
- E. Final determination of compliance with these specifications shall rest solely with the Owner and Engineer who will require proof of prior satisfactory performance.
- F. For any equipment submitted for approval, the BMS contractor shall state what, if any, specific points of system operation differ from these specifications.
- G. The BMS contractor shall continue to bear the liability for replacement of substituted equipment in the event that the equipment fails to perform as specified, or to meet approval of all authorities having jurisdiction, within twelve (12) months after beneficial use by the owner.

#### 1.8 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors.
  - 1. Revise shop drawings to reflect actual installation and operating sequences.
  - 2. Submit data specified in "Submittals" in final "Record Documents" form.

- C. Operation and Maintenance Data:
  - 1. Submit interconnection wiring diagrams complete field installed systems with identified and numbered, system components and devices.
  - 2. Submit keyboard illustrations and step-by-step procedures indexed for each operator function.
  - 3. Submit inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.

#### 1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience, and with service facilities within 100 miles of Project.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

#### 1.10 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

#### 1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.12 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Any manufacturing or installation defects arising during the warranty period shall be corrected without cost to the owner. During the warranty period the owner shall be entitled to unlimited phone support without additional cost. There shall also be no maintenance fees for the system during the warranty period and if any software upgrades occur during this period they shall be installed at no cost.

#### 1.13 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish, program and install one extra wall mounted space temperature sensor and one extra wall mounted humidity sensor per owner/Engineer direction.

## PART 2 PRODUCTS

### 2.1 DIRECT DIGITAL CONTROLS

- A. Manufacturers: Alerton as represented by Automated Building Systems (ABS).
- B. Other manufacturers offering similar products:
  - 1. Automated Logic.
  - 2. Environmental Systems Corporation.

### 2.2 BUILDING MANAGEMENT SYSTEM

- A. BMS shall consist of an information sharing network of stand-alone Direct Digital Control Panels (DDCP's/Controllers), Application Specific Controllers (ASC's), Terminal Equipment Controllers (TEC's) to monitor and control equipment per the sequence of operations and the input/output summary.
- B. "Information sharing" shall be defined as: the function of each controller to exchange data on the network trunk with other controllers without the need for additional devices such as network managers, gateways or central computers.
- C. "Stand-alone" shall be defined as: the function of each controller to independently monitor and control connected equipment through its own microcomputer.
- D. All control devices will be electronic.

### 2.3 ADVANCED WORKSTATION (AWS)

- A. General structure of workstation interaction shall be a standard client/server relationship with web server embedded in the server for browser only access. Server shall be used to archive data and store system database. The AWS shall support operation in a virtualized server environment. A single server license shall not restrict system size based on point count (BACnet or Integration).
- B. Data Displays
  - 1. Data displays shall render all data associated with project as called out on drawings and/or object type list supplied. Graphic files shall be created using digital, full color photographs of system installation, AutoCAD or Visio drawing files of field installation drawings, and wiring diagrams from as-built drawings.
  - 2. Data displays shall render data using iconic graphic representations of all mechanical equipment. System shall be capable of displaying graphic file, text, trendlog, and dynamic object data together on each display and shall include animation. Information shall be labeled with descriptors and shall be shown with the appropriate engineering units. All information on any display shall be dynamically updated without any action by the user.
  - 3. Data display frame shall allow user to change all field-resident AWS functions associated with the project, such as setpoints, weekly schedules, exception schedules, etc., from any screen, no matter if that screen shows all text or a

- complete graphic display. This shall be done without any reference to object addresses or other numeric/mnemonic indications.
4. Analog objects shall be displayed with operator modifiable units. Analog input objects may also be displayed as individual graphic items on the display screen as an overlay to the system graphic.
  5. All displays and programming shall be generated and customized by the local use building management system (BMS) supplier and installer. Systems requiring factory development of graphics or programming of DDC logic are specifically prohibited.
  6. AWS shall be supplied with a library of standard graphics, which may be used unaltered or modified by the operator. AWS shall include a library of equipment graphic components to assemble custom graphics. Systems that do not allow customization or creation of new graphic objects by the operator (or with third-party software) shall not be allowed.
  7. A navigation tree for building, equipment and system diagnostic centric display organization shall be available from data display view. The tree navigation contents shall be customizable on a per-user and per-group basis.
  8. Each display may be protected from viewing unless operator credentials have the appropriate access level. An access level may be assigned to each display and system object. The menu label shall not appear on the graphic if the operator does not have the appropriate security level.
  9. Data displays shall have the ability to link to content outside of the BMS system. Such content shall include, but is not limited to launching external files in their native applications (for example, a Microsoft Word document).
  10. A single system software license can support a minimum of 200 user accounts and web access.
  11. Data displays shall support:
    - a. Graphic items with custom geometry that offer both color gradient shading and variable opacity in scale to system variables, both analog and digital, and color range settings. For example, rooms on a floor plan graphic can be made to indicate the space temperature by varying the color of that room.
    - b. Clear and custom geometry navigation buttons to provide intuitive navigation to system display or external URLs.
    - c. Graphic files in JPG, PNG, and GIF file types.
    - d. Viewing of up to 1,024 system data points (Analog, Binary, and/or Multi-state) in a single screen.
    - e. Customizable mouse-over tooltip information of graphic items or data points can be displayed. The tooltips can be turned on and off. The default setting is off.
    - f. Right click capability to directly access system functionality, such as Schedule, Trendlogs, and Alarms associated with a display object selected.
    - g. Automatic zooming to the screen size detected to maximize the size of the display to match screen display area available. The zoom capability can be enabled or disabled, default is enabled. The background color, if solid, will be used to flood fill the remaining screen background.



3. Operator shall be able to change all information for a given weekly or exception schedule if logged on with the appropriate access privileges.
4. Scheduling shall include optimum start based on outside air temperature, current heating/cooling setpoints, indoor temperature and history of previous starts. Each and every individual zone shall have optimum start time independently calculated based on all parameters listed. User shall input schedules to set time that occupied setpoint is to be attained. Optimum start feature shall calculate the startup time needed to match zone temperature to setpoint. User shall be able to set a limit for the maximum startup time allowed.
5. Schedule list shall show all schedules currently defined. This list shall include all standard, holiday and event schedules. In addition, user shall be able to select a list that shows all scheduled points and zones.
6. Display of all three schedules must show all ON times for standard, holiday and event schedules in different colors on a given day. In addition, OFF times for each must also be shown in additional colors. User shall be able to select from standard calendar what days are to be scheduled and same display shall show all points and zones affected. User shall be able to set time for one day and select all days of the week that shall be affected as a recurrence of that same schedule for that given day.
7. Any displayed data that is changeable by the operator may be selected using the right mouse button and the schedule shall then be selectable on the screen. Selection of the schedule using this method shall allow the viewing of the assigned schedule allow the point to be scheduled.
8. Schedule editor shall support drag-n-drop events and holidays onto the schedule calendar.
9. Schedule editor shall support drag-n-drop events default to a two-hour period, which can then be adjusted by the user.
10. Schedule editor shall support drag-n-drop holidays default for OFF all day and can be edited for multiple-day holidays.
11. Schedule editor shall support the view of affected zones when adding or editing timed events of a schedule.
12. The web client shall have the ability to search a list of all scheduled points and zones to access the schedule calendar.
13. Schedule time blocks shall present schedule detail via mouse-over information.

F. Alarm Indication and Handling

1. AWS shall provide visual, printed, and email means of alarm indication. Printout of alarms shall be sent to the assigned terminal and port. Alarm notification can be filtered based on the User ID's authorization level.
2. Web client shall display a persistent alarm state for the system regardless of the data view including points in alarm but not acknowledged, and points that have gone into alarm and returned to normal without being acknowledged.
3. Alarm History shall provide log of alarm messages. Alarm log shall be archived to the hard disk of the AWS. Each entry shall include a description of the event-initiating object generating the alarm. Description shall be an alarm message of at least 256 characters in length. Entry shall include time and date of alarm occurrence, time and date of object state return to normal, time and date of alarm acknowledgment, and identification of operator acknowledging alarm.



4. Alarm messages shall be in user-definable text (English or other specified language) and shall be delivered either to the operator's terminal, client or through remote communication using email (Authenticated SMTP supported).
  5. Web client shall support color-coded indication of current alarms as follows:
    - a. Red indicator shows number of active alarms that have not been acknowledged.
    - b. Yellow indicator shows number of alarms that are still active but have been acknowledged.
    - c. Blue indicator shows number of alarms that have returned to normal but have not been acknowledged.
    - d. Color-coded indicators, when selected by the user, navigate to a pre-filtered view of alarm history.
    - e. Alarm history can be filtered by color-coded indicator states.
  6. Alarm annunciation includes navigation link to a user-selected display or URL.
  7. Any displayed data that is changeable by the operator may be selected using the right mouse button and the alarm shall then be selectable on the screen. Selection of the alarm using this method shall allow the viewing of the alarm history or allow the creation of a new alarm.
- G. Trendlog Information
1. AWS shall periodically gather historically recorded data stored in the building controllers and store the information in the system database. Stored records shall be appended with new sample data, allowing records to be accumulated. Systems that write over stored records shall not be allowed unless limited file size is specified. System database shall be capable of storing up to 30,000 records before needing to archive data. Samples may be viewed at the web client. All trendlog records shall be displayed in standard engineering units.
  2. For trending criteria, refer to Part 3 – Execution.
  3. AWS shall be capable of trending on an interval determined by a polling rate, or change-of-value.
  4. Users shall be able to add and edit trendlogs and the setup information. This includes the information to be logged as well as the interval at which it is to be logged. All operations shall be password protected. Viewing may be accessed directly from any and all graphics on which a trended object is displayed.
  5. AWS shall be capable of using Microsoft SQL as the system database.
  6. Any displayed data that is changeable by the operator may be selected using the right mouse button and the trendlog shall then be selectable from a menu on the screen.
  7. Trending data shall include the following features:
    - a. Software that is capable of graphing the trend-logged object data shall be included.
    - b. Access and ability to create, edit and view are restricted to users by user account credentials
    - c. Specific and repeatable URL defines the trendlog(s) views for browser bookmarking and email compatibility.
    - d. Call out of trendlog value at intersection of trend line and mouse-over vertical axis.
    - e. Trendlog or Energy log and companion logs can be configured to display on one of two independent vertical scales embedded in the display.

- f. Click zoom for control of data set viewed along either graph axis.
- g. User-specifiable start and end dates as well as a fast scroll features that supports click zoom of macro scale view of the data for quickly finding data set based on visual signature.
- h. User export of the viewed data set to MS Excel.
- i. Web browser-based help.
- j. Optional min/max ranges (Upper Control Limits, Lower Control Limits) for each value.

H. Energy Log Information

- 1. AWS shall be capable of periodically gathering energy log data stored in the field equipment and archive the information. Archive files shall be appended with new data, allowing data to be accumulated. Systems that write over archived data shall not be allowed unless limited file size is specified. Display all energy log information in standard engineering units.
- 2. All data shall be stored in database file format for direct use by third-party programs. Operation of system shall stay completely online during all graphing operations.
- 3. AWS operator shall be able to change the energy log setup information as well. This includes the meters to be logged, meter pulse value, and the type of energy units to be logged. All meters monitored by the system may be logged. System shall support using flow and temperature sensors for BTU monitoring.
- 4. AWS shall display data in tabular format form for both consumption and peak values. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.
- 5. Web client shall display data in tabular format and graphical format. Data shall be shown in hourly, daily, weekly, monthly and yearly formats. In each format, the user shall be able to select a specific period of data to view.

I. Demand Limiting

- 1. AWS shall include demand limiting program that includes two types of load shedding. One type of load shedding shall shed/restore equipment in binary fashion based on energy usage when compared to shed and restore settings. The other type of shedding shall adjust operator-selected control setpoints in an analog fashion based on energy usage when compared to shed and restore settings. Shedding may be implemented independently on each and every zone or piece of equipment connected to system.
- 2. Binary shedding shall include minimum of five (5) priority levels of equipment shedding. All loads in a given priority level shall be shed before any loads in a higher priority level are shed. Load shedding within a given priority level shall include two methods. In one, the loads shall be shed/restored in a “first off-first on” mode, and in the other the loads are just shed/restored in a “first off-last on” (linear) fashion.
- 3. Analog shed program shall generate a ramp that is independently used by each individual zone or individual control algorithm to raise the appropriate cooling setting and lower appropriate heating setting to reduce energy usage.



4. AWS shall be able to display the status of each and every load shed program. Status of each load assigned to an individual shed program shall be displayed along with English description of each load.

J. Reports

1. AWS shall be capable of periodically producing reports of trendlogs, alarm history, tenant activities, device summary, energy logs, and override points. The frequency, content, and delivery are to be user adjustable.
2. All reports shall be capable of being delivered in multiple formats including text- and comma-separated value (CSV) files. The files can be printed, emailed, or saved to a folder, either on the server hard drive or on any network drive location.

K. Configuration/Setup

1. Provide means for operator to display and change system configuration. This shall include, but not be limited to system time, day of the week, date of daylight savings set forward/set back, printer termination, port addresses, modem port and speed, etc. Items shall be modified using understandable terminology with simple mouse/cursor key movements.
2. The building management system (BMS) shall operate the user interface in any region and support varying languages and locale settings, without the addition of special software. Localization tools shall be commonly available open sourced or purchased products, manufacturer specific software shall not be used.
  - a. The following localization capabilities shall be supported:
    - 1) Locale settings related to date, time and number formats
    - 2) Multiple left-to-right languages supported including Cyrillic languages
    - 3) On the fly locale change using browser language settings (multiple language and locale setting change)
    - 4) Default character encoding shall be UTF-8
    - 5) Each localized BMS element can be localized independently and operate autonomously

L. Field Engineering Tools

1. AWS shall include field engineering tools for programming all controllers supplied. All controllers shall be programmed using graphical tools that allow the user to connect function blocks on screen that provide sequencing of all control logic. Function blocks shall be represented by graphical displays that are easily identified and distinct from other types of blocks. Graphical programming that uses simple rectangles and squares is not acceptable.
2. User shall be able to select a graphical function block from menu and place on screen. Provide zoom in and zoom out capabilities. Function blocks shall be downloaded to controller without any reentry of data.
3. Programming tools shall include a real-time operation mode. Function blocks shall display real-time data and be animated to show status of data inputs and outputs when in real-time operation. Animation shall show change of status on logic devices and countdown of timer devices in graphical format.
4. Field engineering tools shall also include a database manager of applications that include logic files for controllers and associated graphics. Operator shall be able

- to select unit type, input/output configuration and other items that define unit to be controlled. Supply minimum of 250 applications as part of workstation software.
5. Field engineering tool shall include Device Manager for detection of devices connected anywhere on the BACnet network by scanning the entire network. This function shall display device instance, network identification, model number, and description of connected devices. It shall record and display software file loaded into each controller. A copy of each file shall be stored on the computer's hard drive. If needed, this file shall be downloaded to the appropriate controller using the mouse.
  6. AWS shall automatically notify the user when a device that is not in the database is added to the network.
  7. AWS shall include backup/restore function that will back up entire system to selected medium and then restore system from that medium. The system shall be capable of creating a backup for the purpose of instantiating a new client PC.
  8. The system shall provide a means to scan, detect, interrogate, and edit third-party BACnet devices and BACnet objects within those devices.
- M. Workstation Hardware and Accessories:
1. Provide one (1) operator's workstation in Lower Level Mechanical Room or other location(s) as coordinated with users.
  2. AWS Server Minimum Requirements
    - a. 64-bit OS
    - b. Windows 10 or Windows Server 2012
    - c. 2 GHz (or better), eight-core processors
    - d. 8 GB RAM or higher
    - e. 32 GB of hard drive space required for base installation without application data
    - f. Minimum 1 TB hard drive. Also see criteria in Specification Section 23 0993.
    - g. Network interface card (10/100/1000 Mbps)
    - h. Wireless keyboard and mouse
    - i. 27" LCD monitor.
    - j. Wireless network card.
  3. Printer
    - a. A separate Laser jet type printer shall be provided for hard copy data and alarm printouts. All change of state reporting system logs, information summaries, system malfunctions and alarms shall be printed at this terminal.
    - b. The minimum acceptable print speed shall be 300 characters per second. The printer shall have a line length of at least 80 characters and the character set shall be the standard 191 character ASCII upper case subset.
    - c. The printer shall be interfaced to the system by standard USB port.

N. Software

1. At the conclusion of the project, contractor shall leave with owner an electronic copy that includes the complete software operation system and project graphics, setpoints, system parameters, etc. This backup shall allow the owner to completely restore the system in the case of a computer malfunction.

O. Web Client

1. BMS supplier shall provide an HTML5-based browser access to the AWS as part of standard installation. User must be able to access all displays of real-time data that are part of the AWS using a standard web browser. Web browser shall tie into the network through owner-supplied Ethernet network connection. The web client shall support a minimum of 200 users with a single license.
2. Browser shall be standard version of Microsoft Internet Explorer v10.0 or later, Firefox v19.0 or later, Chrome v24.0 or later, and Safari v7.1.1 or later. No special vendor-supplied software shall be needed on computers running browser. Data shall be displayed in real-time and update automatically without user interaction.
3. Web pages shall be automatically generated using HTML5 from the data display files that reside on the AWS. Any system that requires use of an HTML editor for generation of web pages shall not be considered.
4. Access to the AWS shall utilize the same hierarchical security scheme as the AWS. User shall be asked to log on once the client makes connection to the AWS. Once the user logs on, any and all changes that are made shall be tracked by the AWS. The user shall be able to change only those items he or she has authority to change. A user activity report shall show any and all activity of the users who have logged on to the system.
5. Shall provide User Session Management including the ability to view all connected user sessions to the web client, see how long they have been active/inactive for each unique session, and force log-out for any or all sessions.
6. Shall provide menu-style navigation access to primary features, i.e. alarm history, trending, Search scheduled points and Zones, System Activity, User Session Management, and Top Display
7. Web client shall, at a minimum, support the following tablets:
  - a. Android platform:
    - 1) Google Nexus
    - 2) Samsung Galaxy Note
  - b. Apple platform
    - 1) Ipad
    - 2) Apple Ipad Mini

## 2.4 BUILDING CONTROLLER

### A. General Requirements

1. BACnet Conformance
  - a. Building Controller shall be approved by the BTL as meeting the BACnet Building Controller requirements.
  - b. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
2. Building controller shall be of scalable design such that the number of trunks and protocols may be selected to fit the specific requirements of a given project.
3. The controller shall be capable of panel-mounted on DIN rail and/or mounting screws.
4. The controller shall be capable of providing global control strategies for the system based on information from any objects in the system, regardless if the object is directly monitored by the building controller module or by another controller.
5. The controller shall be capable of running up to six (6) independent control strategies simultaneously. The modification of one control strategy does not interrupt the function or runtime others.
6. The software program implementing the DDC strategies shall be completely flexible and user-definable. All software tools necessary for programming shall be provided as part of project software. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site, using a wide area network (WAN) or downloaded through remote communications are not acceptable. Changing global strategies using firmware changes is also unacceptable.
7. Programming shall be object-oriented using control function blocks and support DDC functions. All flowcharts shall be generated and automatically downloaded to controller. Programming tool shall be supplied and be resident on workstation. The same tool shall be used for all controllers.
8. The programming tool shall provide means to graphically view inputs and outputs to each program block in real-time as program is executing. This function may be performed using the operator's workstation or field computer.
9. Controller shall have 6,000 Analog Values and 6,000 Binary Values.
10. Controller IP configuration can be done via a direct USB connect with an operator's workstation or field computer.
11. Controller shall have at a minimum a Quad Core 996Ghz processor to ensure fast processing speeds.
12. Global control algorithms and automated control functions shall execute using a 64-bit processor.
13. Controller shall have a minimum of 1 GB of DDR3 SDRAM on a 533Mhz bus to ensure high speed data recording, large data storage capacity and reliability.

14. Controller shall support two (2) on-board EIA-485 ports capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
  - a. Ports are capable of supporting various EIA-485 protocols including, but not limited to BACnet MS/TP and Modbus.
15. Controller shall support two (2) ports—each of gigabit speed—Ethernet (10/100/1000) ports.
  - a. Ports are capable of supporting various Ethernet protocols including, but not limited to BACnet IP, FOX, and Modbus.
16. All ports shall be capable of having protocol(s) assigned to utilize the port's physical connection.
17. The controller shall have at a minimum four (4) onboard inputs, two (2) universal inputs and two (2) binary inputs.
18. Schedules
  - a. Building controller modules shall provide normal seven-day scheduling, holiday scheduling and event scheduling.
  - b. Each building controller shall support a minimum of 380 BACnet Schedule Objects and 380 BACnet Calendar Objects.
19. Logging Capabilities
  - a. Each building controller shall log as minimum 2,000 objects at 15-minute intervals. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
  - b. Logs may be viewed both on-site or off-site using WAN or remote communication.
  - c. Building controller shall periodically upload trended data to networked operator's workstation for long-term archiving if desired.
  - d. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
20. Alarm Generation
  - a. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
  - b. Each alarm may be dialed out as noted elsewhere.
  - c. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
  - d. Controller must be able to handle up to 2,000 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.
21. Demand Limiting
  - a. Demand limiting of energy shall be a built-in, user-configurable function. Each controller module shall support shedding of up to 1,200 loads using a minimum of two types of shed programs.
  - b. Load shedding programs in building controller modules shall operate as defined in section 2.1.J of this specification.

22. Tenant Activity Logging
  - a. Tenant Activity logging shall be supported by a building controller module. Each independent module shall support a minimum of 380 zones.
  - b. Tenant Activity logging shall function as defined in section 2.1.K of this specification.
  
- B. BACnet MS/TP
  1. BACnet MS/TP LAN must be software-configurable from 9.6 to 115.4Kbps
    - a. Each BACnet MS/TP LAN shall support 64 BACnet devices at a minimum.
    - b. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
  
- C. BACnet IP
  1. The building controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the local area network (LAN).
  2. Must support interoperability on WANs and campus area networks (CANs), and function as a BACnet Broadcast Management Device (BBMD).
  3. Each controller shall support at a minimum 128 BBMD entries.
  4. BBMD management architecture shall support 3,000 subnets at a minimum.
  5. Shall support BACnet Network Address Translation.
  6. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
  
- D. Expansion Ports
  1. Controller shall support two (2) expansion ports.
    - a. Combining the two on-board EIA-458 ports with fully loaded expansion ports, the controller shall support six (6) EIA-485 trunks simultaneously.
  2. Expansion cards that mate to the expansion ports shall include:
    - a. Dual port EIA-485 card.
    - b. LON network card.
  
- E. Power Supply
  1. Input for power shall be as shown on the contract documents.
  2. Optional rechargeable battery for shutdown of controller including storage of all data in flash memory.
  3. On-board capacitor will ensure continuous operation of real-time clocks for minimum of 14 days.



- F. Controller shall be in compliance with the following:
    - 1. UL 916 for open energy management
    - 2. FCC Class B
    - 3. ROHS
    - 4. IEC 60703
    - 5. C-Tick Listed
  
  - G. Controller shall operate in the following environmental conditions:
    - 1. -4 to 149 °F (-20 to 65 °C) without optional battery, or 32 to 122 °F (0 to 50 °C) with optional battery.
    - 2. 0 to 95% relative humidity (RH), non-condensing.
- 2.5 WATER SOURCE HEAT PUMP PLANT AND AIR HANDLER APPLICATION CONTROLLERS
- A. Provide one or more native BACnet application controllers for each air handler and provide native BACnet application controllers as needed for central plant control that adequately cover all objects listed in object list. All controllers shall interface to building controller through either MS/TP LAN using BACnet protocol, or Ethernet LAN using BACnet over Ethernet or BACnet TCP/IP. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of units. Controllers shall be fully programmable using graphical programming blocks. Programming tool shall be resident on operator workstation and be the same tool as used for the building controller. No auxiliary or non-BACnet controllers shall be used.
  
  - B. BACnet Conformance
    - 1. Application controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.
    - 2. Please refer to section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
    - 3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Multi-state Values, Device, File, and Program object types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
  
  - C. Application controllers shall include universal inputs with 12-bit resolution that accept 3K and 10K thermistors, 0–10VDC, Platinum 1000 ohm RTD, 0–5VDC, 4–20mA and dry contact signals. Any input on a controller may be either analog or digital with a minimum of three inputs that accept pulses. Controller shall also include support and modifiable programming for interface to intelligent room sensor with digital display. Controller shall include binary and analog outputs on board. Analog outputs with 12-bit resolution shall support either 0–10VDC or 0–20mA. Binary outputs shall have LED

indication of status. Software shall include scaling features for analog outputs. Application controller shall include 20VDC voltage supply for use as power supply to external sensors.

1. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.
  2. The position of each and every HOA switch shall be available system wide as a BACnet object property.
- D. All program sequences shall be stored on board application controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller up to 20 times per second (minimum of 10 times per second) and capable of multiple PID loops for control of multiple devices. All calculations shall be completed using floating-point math and system shall support display of all information in floating-point nomenclature at operator's terminal.
1. The following control blocks shall be supported:
    - a. Natural Log
    - b. Exponential
    - c. Log base 10
    - d. X to the power of Y
    - e. Nth square root of X
    - f. 5th Order Polynomial Equations
    - g. Astronomical Clock (sunrise/sunset calculation)
    - h. Time based schedules
- E. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely using modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using programming tools as described in operator's terminal section.
- F. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on intelligent room sensor shall be programmable at application controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode, based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.
- G. Schedules
1. The controller shall support a minimum of 3 BACnet Schedule Objects and have a real time clock on board with battery backup to maintain time through a power loss.
- H. Logging Capabilities
1. Controller shall support a minimum of 50 trendlogs. Any object in the controller (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.



2. Controller shall periodically upload trended data to system server for long-term archiving if desired. Archived data stored in (MS Jet Database or SQL) database form and shall be available for use in third-party spreadsheet or database programs.

I. Alarm Generation

1. Alarms may be generated within the controller for any object change of value or state (either real or calculated). This includes things such as analog object value changes, and binary object state changes.
2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
3. Controller must be able to handle up to 25 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

- J. The controller processor shall be minimum 32-bit processor.

- K. The packaging of the controller shall provide operable doors to cover the terminals once installation is complete. The housing of the controller shall provide for DIN rail mounting and also fully enclose circuit board.

## 2.6 EXPANDABLE CENTRAL PLANT APPLICATION CONTROLLERS

A. General

1. Expandable application controller shall be capable of providing control strategies for the system based on information from any or all connected inputs. The program that implements these strategies shall be completely flexible and user-definable. Any systems utilizing factory pre-programmed global strategies that cannot be modified by field personnel on-site through simple download are not acceptable. Changing global strategies using firmware changes is also unacceptable. Program execution of controller shall be a minimum of once per second.
2. Programming shall be object-oriented using control program blocks. Controller shall support a minimum of 500 Analog Values and 500 Binary Values. Each and every analog and binary value shall support standard BACnet priority arrays. Programming tool shall be provided with system and shall be the same tool that is used to program the building controller. All flowcharts shall be generated and automatically downloaded to controller. No re-entry of database information shall be necessary.
3. Provide means to graphically view inputs and outputs on each program block in real-time as program is executing. This function may be performed using the operator's terminal or field computer.
4. Controller shall have adequate data storage to ensure high performance and data reliability. Battery shall retain static RAM memory and real-time clock functions for a minimum of 1.5 years (cumulative). Battery shall be a field-replaceable (non-rechargeable) lithium type. Unused battery life shall be 10 years.
5. The onboard, battery-backed real-time clock must support schedule operations and trendlogs.

6. Global control algorithms and automated control functions should execute using 32-bit processor.
7. Controller shall include both onboard 10Base-T/100Base-TX Ethernet BACnet communication over UTP and shall include BACnet IP communication. In addition, controller shall include BACnet Point-to-Point (PTP) connection port.
8. The base unit of the controller shall host up to 8 expansion modules with various I/O combinations. These inputs and outputs shall include universal 12-bit inputs, binary triac outputs, and 8-bit switch-selectable analog outputs (0–10V or 0–20mA). Inputs shall support 3K and 10K thermistors, 0–5VDC, 0–10VDC, 4–20mA, dry contacts and pulse inputs directly.
9. All outputs must have onboard Hand-Off-Auto (HOA) switches and a status indicator light. HOA switch position shall be monitored. Each analog output shall include a potentiometer for manually adjusting the output when the HOA switch is in the Hand position.
10. The position of each and every HOA switch shall be available system wide as a BACnet object. Expandable central plant controller shall provide up to 176 discreet inputs/outputs per base unit.

B. BACnet Conformance

1. Central plant/AHU controller shall, as a minimum, support PTP, MS/TP and Ethernet BACnet LAN types. It shall communicate directly through these BACnet LANs as a native BACnet device and shall support simultaneous routing functions between all supported LAN types. Controllers shall be approved by the BTL as meeting the BACnet Advanced Application Controller requirements.
2. Please refer to Section 22.2, BACnet Functional Groups, in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All necessary tools shall be supplied for working with proprietary information.
3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Binary Input, Analog Output, Binary Output, Analog Value, Binary Value, Device, File, Group, Event Enrollment, Notification Class, Program, and Schedule object types. All necessary tools shall be supplied for working with proprietary information.
4. The Controller shall comply with Annex J of the BACnet specification for IP connections. This device shall use Ethernet to connect to the IP internetwork, while using the same Ethernet LAN for non-IP communications to other BACnet devices on the LAN. Must support interoperability on WANs and CANs, and function as a BBMD.

C. Schedules

1. Each central plant/AHU controller shall support a minimum of 50 BACnet Schedule Objects.

D. Logging Capabilities

1. Each controller shall support a minimum of 200 trendlogs. Any object in the system (real or calculated) may be logged. Sample time interval shall be adjustable at the operator's workstation.
2. Controller shall periodically upload trended data to system server for long-term archiving if desired.

3. Archived data stored in database format shall be available for use in third-party spreadsheet or database programs.
- E. Alarm Generation
1. Alarms may be generated within the system for any object change of value or state (either real or calculated). This includes things such as analog object value changes, binary object state changes, and various controller communication failures.
  2. Alarm log shall be provided for alarm viewing. Log may be viewed on-site at the operator's terminal or off-site using remote communications.
  3. Controller must be able to handle up to 200 alarm setups stored as BACnet event enrollment objects, with system destination and actions individually configurable.

## 2.7 TERMINAL UNIT APPLICATION CONTROLLERS

- A. Provide one native BACnet application controller for each piece of unitary mechanical equipment that adequately covers all objects listed in object list for unit. All controllers shall interface to building controller through MS/TP LAN using BACnet protocol. No gateways shall be used. Controllers shall include input, output and self-contained logic program as needed for complete control of unit.
- B. BACnet Conformance
1. Application controllers shall, as a minimum, support MS/TP BACnet LAN types. They shall communicate directly using this BACnet LAN at 9.6, 19.2, 38.4 and 76.8 Kbps, as a native BACnet device. Application controllers shall be approved by the BTL as meeting the BACnet Application Specific Controller requirements and support all BACnet services necessary to provide the following BACnet functional groups:
    - a. Files Functional Group
    - b. Reinitialize Functional Group
    - c. Device Communications Functional Group
  2. Please refer to Section 22.2, BACnet Functional Groups in the BACnet standard, for a complete list of the services that must be directly supported to provide each of the functional groups listed above. All proprietary services, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.
  3. Standard BACnet object types supported shall include, as a minimum, Analog Input, Analog Output, Analog Value, Binary Input, Binary Output, Binary Value, Device, File, and Program Object Types. All proprietary object types, if used in the system, shall be thoroughly documented and provided as part of the submittal data. All necessary tools shall be supplied for working with proprietary information.

- C. Application controllers shall include universal inputs with 10-bit resolution that can accept 3K and 10K thermistors, 0–5VDC, 4–20mA, dry contact signals and a minimum of 3 pulse inputs. Any input on controller may be either analog or digital. Controller shall also include support and modifiable programming for interface to intelligent room sensor. Controller shall include binary outputs on board with analog outputs as needed.
- D. All program sequences shall be stored on board controller in EEPROM. No batteries shall be needed to retain logic program. All program sequences shall be executed by controller 10 times per second and shall be capable of multiple PID loops for control of multiple devices. Programming of application controller shall be completely modifiable in the field over installed BACnet LANs or remotely through modem interface. Operator shall program logic sequences by graphically moving function blocks on screen and tying blocks together on screen. Application controller shall be programmed using same programming tools as building controller and as described in operator workstation section. All programming tools shall be provided and installed as part of system.
- E. Application controller shall include support for intelligent room sensor (see Section 2.10.B.) Display on room sensor shall be programmable at controller and include an operating mode and a field service mode. All button functions and display data shall be programmable to show specific controller data in each mode based on which button is pressed on the sensor. See sequence of operation for specific display requirements at intelligent room sensor.

## 2.8 DASHBOARD SCREEN / MONITOR

- A. Monitor shall be wall mounted, flat front screen, nominal 55” LCD display with LED backlighting and HD 1080 resolution.
- B. Monitor shall be touch screen operation and provided with remote control for on-off / volume operations and remote control mouse for day to day user interface. Power shall be 120V plug-in.

## 2.9 SENSORS/INPUT DEVICES TO CONTROLLERS

- A. All space temperature sensors, which are used, as inputs to the Controllers shall be the thermistor or RTD type. The range shall be 40 - 120 degrees F. at a factory calibration point of 77 degrees F. Accuracy shall be  $\pm 0.5$  degrees F at calibration point.
  - 1. Vandal resistant sensors shall be located in Entrance Lobby and shall be stainless steel plate type with reset button.
  - 2. All other sensors shall be wall mounted unless noted otherwise with LCD readout, bias levers and push-button bypass switches.
    - a. Sensor shall contain a backlit LCD digital display and user function keys along with temperature sensor. Controller shall function as room control unit, and shall allow occupant to raise and lower setpoint, and activate terminal unit for override use—all within limits as programmed by building operator. Sensor shall also allow service technician access to hidden functions.

- b. Space sensors shall simultaneously display room setpoint, room temperature, outside temperature, and fan status (if applicable) at each controller. This unit shall be programmable, allowing site developers the flexibility to configure the display to match their application. The site developer should be able to program the unit to display room humidity and outdoor humidity.
  - c. Override time may be set and viewed in half-hour increments; maximum override time set through BMS (adjustable). Override time count down shall be automatic, but may be reset to zero by occupant from the sensor. Time remaining shall be displayed. Display shall show the word "OFF" in unoccupied mode unless a function button is pressed.
  - d. Field service mode shall be customizable to fit different applications. If intelligent room sensor is connected to VAV controller, VAV box shall be balanced and all air flow parameters shall be viewed and set from the intelligent room sensor with no computer or other field service tool needed.
- B. Duct and unit mounted temperature sensors shall averaging style and shall not be single point duct temperature sensors Averaging element sensors shall be the platinum element RTD type with 4 - 20 ma transmitters to eliminate any necessary calibration adjustment for wiring length. The range shall be 20 - 120 degrees F at a factory calibration point of 70 degrees F. Accuracy of the sensor at calibration point shall be  $\pm 1.1$  degrees F.
- C. Outside air temperature sensor shall be the platinum element RTD type with 4 - 20 ma transmitters to eliminate any necessary calibration adjustment for wiring length. The range shall be -58 - 122 degrees F and have accuracy at calibration point  $\pm 0.5$  degrees F.
- D. Low temperature detectors (freezestats) shall be the manual reset type, two-position snap acting. Capillary shall have minimum sensitive length of 20 feet and shall be installed in serpentine fashion downstream from coil it is protecting. Each square foot of coil shall be protected by a section of the capillary. Where large coil size or multiple coil construction exceeds the limit of coverage of one unit, provide additional units placed in series to that coil area coverage is maintained.
- E. Humidity sensors shall be commercial grade with standard 4 - 20 ma outputs. The range shall be 0 -99% RH. Stated accuracy shall be + 5% RH minimum.
- F. CO2 Sensors: Microprocessor based, with LCD display, demand control ventilation interfacing, self calibrating, five year warranty. Sensors shall use single or dual-beam absorption infrared diffusion technology (non-dispersive infrared), and shall have integral programming to perform automatic baseline calibration without user interface. The recommended manual recalibration period shall not be less than five years. Sensors shall meet or exceed the following specifications.
- 1. Operating conditions: 60oF to 90oF; 0 to 95% relative humidity, non-condensing
  - 2. CO2 sampling method: diffusion or flow-through
  - 3. CO2 measurement range: 0 to 10,000 ppm

4. Sensitivity: +10 ppm
  5. Accuracy: +50 ppm from 0 to 2000 ppm, +5% of reading above 2,000 ppm
  6. The sensors shall be provided with the manufacturer's recommended calibration kit. The kit shall include sufficient material to initially calibrate every sensor provided for the project. Combination temperature/CO2 sensors are acceptable (see paragraph A, above).
  7. Mounted at 42" above finished floor.
- G. Water temperature sensors shall be well-mounted insertion liquid temperature sensor, platinum element with a 4 - 20 ma signal transmitted to the DDCP. The ranges used shall be appropriate with the application. The range applied for sensing hot water temperature shall be 70-220 degrees F and for sensing chilled and condenser water temperatures shall be 20-120 degrees F.
- H. Differential Pressure Switches: The differential pressure range of the switch shall be selected to suit the application and shall have an adjustable set point. The switch shall have SPDT contacts rated at 9 amperes at 120 volt AC and be UL approved. The switch shall be mounted with the diagram in a vertical plan. The switch shall be capable of withstanding full system pressure on either side of the sensing element with atmospheric pressure on the other side, without damage to the switch or degradation of its calibration. Dwyer AFS-262 for air and Penn P74 for liquid or approved equal.
- I. Temperature, Pressure, Flow and Level Transmitters: Transmitters shall produce a 4 to 20 mA output linearly proportional to the measured variable, with a minimum accuracy of .5% of the transmitter range. The range shall not exceed 200% of the measured variable's normal maximum value. Differential pressure transmitters shall be Kele and Associates Model 360C or approved equal.
- J. Duct (or System) Static Pressure Measuring Devices: Provide, where indicated, duct static measuring devices capable of continuously monitoring the duct or system static pressure it serves.
1. The pressure range of the switch shall be selected to suit the application and shall have an adjustable set point and deadband. The switch shall have at least one SPDT contact rated at 9 amperes at 120 volt AC and be UL approved.
  2. The duct static traverse probe shall be of extruded aluminum construction and (except for 3/4" diameter probes with lengths of 24" or less) be complete with threaded end support rod, sealing washer and nut, and mounting plate with gasket and static pressure signal fitting. The static traverse probe shall be capable of producing a steady, non-pulsating signal of standard static pressure, without need for correction factors, with an instrument accuracy of 0.5%.
  3. Pressure Transmitters shall be the 4 - 20 ma output type with zero and span adjustments. The range shall be 0-00.5", 0-1", 0-2", 0-5", or 0-10" w.c. as required by the application. Combined static error (non-linearity and hysteresis) shall be  $\pm 1\%$  of full range output. Transmitters shall be supplied to transmit a 4-20 ma signal to the DDCP for every flow measuring station and duct static pressure traverse probe.



- K. Airflow Measuring / Monitoring Stations - Fan inlets with round cowlings:
  - 1. The measuring station shall not significantly impact fan performance or contribute to fan generated noise levels. The probes shall be capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors, with an accuracy of 3% of actual flow over a fan operating range of 6 to 1 capacity turndown.
  - 2. Transmitter shall be 24 VAC power with 4-20 ma output signal. Transmitter shall have an accuracy of  $\pm 0.5\%$  of Natural Span and be furnished with a built-in 3-way zeroing valve, user selectable square root function, and integral  $3\frac{1}{2}$  digit scalable LCD for display of measured process. The Transmitter shall be housed in a NEMA 12 steel enclosure with universal 1/8" FPT signal connection ports
  
- L. Airflow Measuring / Monitoring Stations – Duct mounted, outside air hoods, exhaust hoods and all other applications:
  - 1. Probes shall be thermal dispersion airflow and temperature measurement device. Accuracy shall be 3% or better of actual flow over 0 to 5,000 fpm velocities. Each measurement device shall consist of one or more sensor probe assemblies. Multiple sensor housings shall be equally weighted and averaged by the transmitter prior to output. Provide stand-off mounting hardware when installing probes inside the casing of air handling equipment. Modify air handling unit hoods to provide laminar airflow across measuring station to guarantee 3% or better accuracy.
  - 2. Transmitter shall be 24 VAC power with 4-20 ma output signal. Transmitter shall include LCD for display.
  
- M. Water Flow Meters shall be as manufactured by Onicon F-1000 Series, Neptune or Omega. Meters shall be in-line, turbine type approved for potable water. Accuracy shall be 1.0% at 3 to 30 feet per second flow rate. Provide with 24VAC power connections and pulse output signal.
  
- N. Aquastats shall be pipe mounted, 24 VAC.
  
- O. Wall mounted switches shall be toggle type, 24 VAC.
  
- P. Current sensing relay shall be digital output.
  
- Q. Water leak detectors shall be probe type, 24 VAC; Dwyer WD3 with mounting bracket or approved equal. Provide with DPDT relay and audible alarm.
  
- R. Audio/Visual Alarms shall be indication station with visual alarm, audible alarm, silence button dry input contact and 24 VAC power.
  
- S. Occupancy sensors shall be ceiling mounted, 24 VAC power, with two (2) dry contacts, programmable off time period and programmable sensitivity level.
  
- T. Glycol Refractometer (GR) shall be AFAB Enterprises Model PR-111, Misco Model M-111 or Dynalene. Power supply shall be 120V, 1 phase or 24 VAC, 1 phase. BMS contractor shall provide branch circuit power to device. GR shall be provided with

stainless steel sensing element, 4-20 mA output and 0-100% analog display meter. Provide adapters for varying pipe sizes. GR shall be calibrated over a 60°F range for types of glycol and % of solution as shown on the drawings.

- U. Space differential pressure transmitter / sensor shall be 24 VAC power, 0 to 10 VDC or 4 to 24 ma output signal.
- 2.10 CONTROL DAMPERS AND MOTORIZED DAMPERS

- A. All dampers shall be thermally insulated and thermally broken or approved equal.
- B. Extruded aluminum (6063T5) damper frame shall not be less than .080" thickness. Damper frame to be 4" deep. Entire frame shall be thermally broken by means of polyurethane resin pockets, complete with thermal cuts.
- C. Blades to be extruded aluminum (6063T5) profiles, internally insulated with expanded polyurethane foam and shall be thermally broken. Complete blade shall have an insulating factor of R-2.29 and a temperature index of 55. Blade and frame seals shall be of extruded silicone and be secured in an integral slot within the aluminum extrusions.
- D. Maintenance-free bearings are to be composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
- E. Linkage hardware shall be installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- F. Modulating dampers (designated with "AO" shall be opposed blade action. Open/close dampers (designated with "DO") shall be parallel blade action.
- G. Leakage shall not exceed 3 cfm/ft<sup>2</sup> against 1" w.g. differential static pressure. Pressure drop of a fully open 48" x 48" damper shall not exceed .03" w.g. at 1000 fpm.
- H. Dampers shall be made to size required without blanking off free area. Dampers shall be available as "Flanged to Duct" mounting type.
- I. Damper Actuators shall be electronic type and shall be either fully proportional spring return or two-position spring return as described in the sequence of operation and as shown on the control drawings. Damper operators shall be located outside the air stream. Damper actuators shall be of sufficient size to operate their respective dampers effectively. End switches shall be provided for all actuators. BMS shall connect and monitor end switches as indicated on Mechanical Control Drawings, related mechanical drawings and Specification Section 230993.



2.11 CONTROL VALVES – DIGITAL SIGNAL

- A. Control valves shall be 24VAC, two-position, spring-return, normally open with a maximum differential pressure of 60 PSIG.
- B. Spring return, electronic motor actuators shall position control valves. All valves shall have shutoff discs and V-ring packing. Valve sizes of 1/2 through 2 inches shall be furnished with screwed or soldered ends with stainless steel or bronze trim to suit the application. Flanged valves with bronze trim shall be furnished for sizes 2 1/2 inch and larger. Lug type butterfly valves with bronze discs and disc seals suitable for the medium and expected temperature range may be used for valve sizes of 5 inch or larger provided that the control signal for modulating valve applications employs both proportional and integral algorithms. The minimum rating for valve bodies shall be ANSI class 125.
- C. The BMS contractor shall size each control valve to provide the proper flow rate at the available differential pressure, and shall include the Cv of each valve in his submittal.

2.12 CONTROL VALVES – ANALOG SIGNAL

- A. The electronic actuator shall mount on the valve body and provide complete modulating control of the valve. The electronic actuator shall receive a 24 VAC floating control signal, 0-10vdc or 4-20ma to control the valve. Valves shall be bronze body with stainless steel trim. The minimum rating for valve bodies shall be ANSI class 12..
- B. Valves 2 1/2 inches or less shall be globe valve style or ball valve produced for modulating control (“equal percentage valve”). Globe valves shall be bronze body, bronze trim, screwed bonnet, non-asbestos packing, renewable composition disc and bronze seat, Class 125, threaded or solder ends. Ball valves shall be bronze two piece body, blowout-proof stem, stainless steel ball with Teflon insert, Teflon seats and packing with solder or threaded ends
- C. Valves 3 inches and over shall be globe valve style with iron body, bronze trim, bolted bonnet, non-asbestos packing, rotating plug-type disc with renewable seat ring and disc, Class 125, flanged ends.

2.13 VARIABLE FREQUENCY DRIVES/CONTROLLERS

- A. Manufacturers: ABB ACH500 or approved equal as manufactured by Schneider Electric or Yasakwa.
- B. DESCRIPTION
  - 1. Enclosed variable frequency controllers suitable for operating the indicated loads, in conformance with requirements of NEMA ICS 7.
  - 2. Select unspecified features and options in accordance with NEMA ICS 3.1.

C. RATINGS

1. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
2. Operating Ambient: 0 degrees C to 40 degrees C.

D. DESIGN

1. Employ microprocessor-based inverter logic isolated from power circuits.
2. Employ pulse-width-modulated inverter system.
3. Design for ability to operate controller with motor disconnected from output.
4. Design to attempt five automatic restarts following fault condition before locking out and requiring manual restart.

E. PRODUCT OPTIONS AND FEATURES

1. Display: Provide integral digital display to indicate output voltage, output frequency, and output current.
2. Status Indicators: Separate indicators for overcurrent, overvoltage, ground fault, overtemperature, and input power ON.
3. Volts Per Hertz Adjustment: Plus or minus 10 percent.
4. Current Limit Adjustment: 60 - 110 percent of rated.
5. Acceleration Rate Adjustment: 0.5 - 30 seconds.
6. Deceleration Rate Adjustment: 1 - 30 seconds.
7. Furnish HAND-OFF-AUTOMATIC selector switch and manual speed control.
8. Input/Output Signals:
  - a. 4-20 mA input central signal.
  - b. 4-20 mA output feedback signal.
  - c. Contact closure for general alarm output.
9. Door Interlocks: Furnish mechanical means to prevent opening of equipment with power connected, or to disconnect power if door is opened; include means for defeating interlock by qualified persons.
10. Safety Interlocks: Furnish terminals for remote contact to inhibit starting under both manual and automatic mode.
11. Control Interlocks: Furnish terminals for remote contact to allow starting in automatic mode.
12. Manual Bypass: Furnish contactor, motor running overload protection, and short circuit protection for full voltage, non-reversing operation of the motor. Include isolation switch to allow maintenance of inverter during bypass operation.
13. Disconnecting Means: Include integral fused disconnect switch on the line side of each controller.

F. FABRICATION

1. Wiring Terminations: Match conductor materials and sizes indicated.
2. Enclosure: NEMA 250, Type 1.
3. Finish: Manufacturer's standard enamel.

## PART 3 EXECUTION

### 3.1 INSTALLATION OF COMPONENTS

- A. Locate and install components for easy accessibility; in general, mount 48 inches above floor with minimum 3'-0" clear access space in front of units where not subject to excessive vibration. Obtain approval on locations from owner's representative prior to installation.
- B. Install software in control units and in operator workstation. Implement features of programs to specified requirements and appropriate to sequence of operations.
- C. Extend 120 VAC power to control transformers at locations shown on the drawings. Provide control transformers and low voltage wiring to all control components including sensors, actuators, etc.
- D. All instruments, switches, transmitters, etc., shall be suitably wired and mounted to protect them from vibration, moisture and high or low temperatures.
- E. Identify all equipment and panels. Provide permanently laminated plastic labels at all devices and panels.
- F. Provide stainless steel or brass thermowells suitable for respective application and for installation under other sections—sized to suit pipe diameter without restricting flow.
- G. Glycol Refractometer (GR) shall be installed in 1" bypass line with isolation valves and manual type balance valve. Bypass line shall be installed from pump suction to pump discharge.
- H. Install outdoor air temperature sensors on north wall complete with sun shield at manufacturer's recommended location.
- I. Control components shall be calibrated against actual measurement of flow, temperature, humidity, etc. as recorded in conjunction with Specification Section 230593.

### 3.2 PROGRAMMING

- A. Provide sufficient internal memory for all controllers to ensure specified sequence of operations, alarming, trending, and reporting requirements are achieved. BMS manufacturer shall provide a minimum of 25% spare memory capacity for future use.
- B. Point Naming: System point names shall be modular in design, allowing easy operator interface without the use of a written point index.
- C. Software Programming: Provide programming for individual mechanical systems to achieve all aspects of the sequence of operation specified. It is the BMS manufacturer's responsibility to ensure all mechanical equipment functions and operates as specified in sequence of operations. Provide sufficient programming comments in controller

application software to clearly describe each section of the program. The comment statements shall reflect the language used in the sequence of operations.

- D. BMS Operator's Interface
    - 1. At the Operator Workstations, provide color graphics for each piece of mechanical equipment depicting sufficient I/O to monitor and troubleshoot operation. Additionally, provide individual floor plans of the building allowing an operator to quickly view the overall floor plan area for any out of tolerance conditions that may need addressing. These standard graphics shall depict all points dynamically as specified in the points list and/or indicated in sequence of operation.
    - 2. The BMS manufacturer shall provide all the labor necessary to install, initialize, start-up, and trouble-shoot all operator interface software and their functions as described in this section. This includes any operating system software, the operator interface data, and any third party software installation and integration required for successful operation of the operator interface.
    - 3. As part of this execution phase, the BMS manufacturer shall perform a complete test of the operator interface.
- 3.3 TRENDING AND ALARM NOTIFICATION
- A. Refer to Specification Section 23 0993.
- 3.4 IDENTIFICATION OF HARDWARE AND WIRING
- A. BMS manufacturer to coordinate labeling nomenclature with mechanical equipment manufacturer and other contractors.
  - B. All field wiring and cabling shall be labeled at each end within 2" of termination with a cable identifier and other descriptive information for troubleshooting, maintenance, and service purposes.
  - C. At each control panel and controller, provide as-built drawing (maximum size 11x17) inside each controller listing each terminal point and descriptive information for troubleshooting, maintenance, and service purposes.
  - D. Identify control panels and controllers with minimum 1-cm letters on laminated plastic nameplates.
  - E. Identify relays with P-touch type labeler.
  - F. Identifiers shall match record documents. All plug-in components shall be labeled such that removal of the component does not remove the label.

3.5 SYSTEMS TURN-OVER

- A. Schedule work under the provisions of Division 1.
- B. Upon completion of the project, check, validate, and calibrate, where required, all controllers, controlled devices, valves, actuators, auxiliary devices, relays, etc. provided under this section
- C. Coordinate work with balancing contractor in respect to calibration, balancing at varying conditions, etc. Contractor shall be on site when all balancing is occurring.
- D. Upon completion of the installation, the Contractor shall start-up the system and perform all necessary testing and run diagnostics to ensure proper operation. An Acceptance Test in the presence of the Owner's Commissioning Agent shall be performed. The acceptance test shall consist of a point-to-point check to insure proper operation of all system components.
- E. Contractor shall provide a report indicating devices checked, status, date, follow-up status, etc. Report shall be submitted prior to Functional Testing by the Owner and/or Commissioning Agent.
- F. Problems which occur shall be corrected in an appropriate fashion under warranty. Any such occurrence shall not void previous approval; however, the Control Contractor shall be responsible to attend to, and remedy, such items within the warranty period. Appropriate logs, schedules, and reports shall be maintained to reflect these items and their redress.

3.6 TRAINING/OWNER'S INSTRUCTIONS

- A. The Control Contractor shall provide two (2) copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system.
- B. The Contractor shall instruct the owner's designated representative in these procedures during the start-up and test period. The duration of the instructions is to be conducted during normal working hours and shall be no less than forty (40) hours.
- C. The instructions shall consist of both hand-on and classroom training at the job site. Operational questions, which can be answered over the telephone, will be handled at no additional cost and will not count toward the forty hours of formal training.

END OF SECTION 230923

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## SECTION 230993 SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes sequence of operation for:
  - 1. Central geothermal heating/cooling plant systems.
  - 2. Hot and chilled water pumps.
  - 3. Air handling units.
  - 4. ERV's
  - 5. Fans.
  - 6. Radiation
  - 7. Air terminal units.
  - 8. Unit heaters and cabinet unit heaters.
  - 9. Domestic hot water.
  - 10. Pressure controls.
  - 11. Dehumidification.
  - 12. Heating and cooling monitoring and controls.
  - 13. Airflow monitoring and controls
  - 14. Natural ventilation
  - 15. Demand response load shedding.
  - 16. Trombe wall heat recovery.
  - 17. Dashboard programming.
  - 18. Trending and recording data for Monitoring Based Cx.
  - 19. Alarms per Monitoring Based Cx.
  - 20. Miscellaneous monitoring.
  
- B. Related Sections:
  - 1. Section 01 91 13 – General Commissioning Requirements
  - 2. Section 23 04 00 – General Conditions for Mechanical Trades
  - 3. Section 23 09 23 - Direct-Digital Control System for HVAC: For equipment, devices, system components, and software to implement sequences of operation.

#### 1.2 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Shop Drawings: Indicate mechanical system controlled and control system components.
  - 1. Label with settings, adjustable range of control and limits. Submit written description of control sequence.
  - 2. Submit flow diagrams for each control system, graphically depicting control logic.
  - 3. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.
  - 4. Coordinate submittals with information requested in Section 23 09 23.

1.3 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

PART 2 PRODUCTS

Not Used.

PART 3 EXECUTION

3.1 CONTROL DEVICES

- A. All devices and sensors shall be adjustable. BMS shall display setpoints and actual conditions of all control devices and position of all actuators at the central personal computer (PC)

3.2 GENERAL DEVICES

- A. Variable Frequency Drives: BMS shall control start/stop of each VFD and shall monitor a general alarm contact at the VFD. If the VFD is in alarm mode, an alarm shall be activated at the central PC. BMS shall control speed of each VFD and monitor speed feedback.
- B. Filter Differential Pressure Transmitters: BMS shall monitor DPT's and alarm if the differential pressure is above setpoint.
- C. Space Differential Pressure Sensors: BMS shall monitor space sensors as shown on the drawings.
- D. Carbon Dioxide at Exterior of the Building: BMS shall monitor and record carbon dioxide levels.
- E. Sump Pump: BMS shall monitor for trouble and alarm signals; and shall send an alarm if in alarm mode.
- F. Fire Alarm: BMS shall monitor general alarm input signal.
- G. Leak Detectors: BMS shall monitor leak detectors and shall send an alarm if detector is in alarm mode.

3.3 SPACE TEMPERATURE /HUMIDITY CONTROL AND OVERRIDE BUTTONS

- A. Systems are served by multiple space sensors. BMS shall average the space temperature and humidity to determine stages of cooling, heating and dehumidification.



- B. Certain areas are served by override button. If an override button is activated the space with the button becomes the primary space to be conditioned and other sensor inputs shall not control the temperature and humidity. SOP shall revert back to averaging type after one hour.

#### 3.4 DOMESTIC HOT WATER AND PUMPS

- A. Water Heater WH-1 Scheduling: Water heater on-off shall be controlled per a time of day schedule and shall be activated during occupied modes.
- B. Domestic Hot Water Recirculating Pumps serving WH-1 and WH-2: Pump shall be controlled per a time of day schedule and shall be activated during occupied modes. If temperature at inlet to pump drops below 105F, pump shall start. If temperature at inlet to pump rises above 110F, pump shall stop.
- C. Domestic Hot Water HWHX-1: BMS shall monitor temperature in tank to maintain minimum 107F. If temperature drops below 105F, HPP-DW-1 lead pump shall start and BMS shall signal HP-DW1 to be active. Lead pump GWP-1 shall start and GWS&R control valve associated with HP-DW1 shall open. If temperature in tank rises above 107F, pumps shall stop and control valve shall close and heat pump shall be de-activated.

#### 3.5 GLYCOL/WATER SOLUTION MAKEUP AND REFRACTOMETER FOR GLYCOL

- A. Glycol Make-up: BMS shall monitor pressure transmitter. When pressure is below setpoint, BMS shall activate respective glycol makeup pump. When pressure is at setpoint, pump shall stop.
- B. BMS shall monitor general alarm output at each glycol makeup unit.
- C. Glycol Refractometer: BMS shall monitor the meter and provide a readout as % PPG. If the percent glycol is 3% deviant from setpoint a trouble condition shall occur at the central PC. If the percent glycol is 5% deviant from setpoint an alarm condition shall occur at the central PC.

#### 3.6 LEAD / STANDBY PUMPING SYSTEMS

- A. Sequence of operation apply to:
  - 1. Pumps GLP-1 and GLP-2.
  - 2. Pumps GWP-1 and GWP-2.
  - 3. Pumps HPP-DW-1 and HPP-DW-2.
  - 4. Pumps HWP-1 and HWP-2.
  - 5. Pumps CHWP-1 and CHWP-2.
- B. Lead pump shall start per sequences of operation described in other sections of this specification.
- C. Designation of lead and standby pump shall be automatically alternated based on user defined run times or day of the week.

- D. When the pump is enabled, the pump VFD status determines if the motor is operating. After an operator definable feedback time delay, if there is an indication that the pump is not operating, the standby pump shall be enabled and an alarm shall be generated. Conversely, if status is detected while pump is turned off, a separate alarm shall be generated.

### 3.7 CHILLED WATER AND HOT WATER PUMPING SYSTEMS

- A. Sequences of operation apply to:
  - 1. Pumps HWP-1 and HWP-2.
  - 2. Pumps CHWP-1 and CHWP-2.
  - 3. Pumps GWP-1 and GWP-2.
- B. Pump VFD Operation / Hot Water Differential Pressure (DP) Reset.
  - 1. BMS shall modulate pump VFD to maintain DP setpoint at each DPT. Pump speed shall be increased in response to transmitter with highest demand (transmitter with DP furthest below setpoint. DP at each sensor shall be allowed to increase above setpoint if pump speed needs to increase to maintain DP at a sensor which is below setpoint
  - 2. BMS shall reset the differential pressure (DP) setpoint based on control valve positions. There are multiple DPT's. BMS contractor shall assign each control valve to a specific DPT that it is served by.
  - 3. Differential setpoint shall operate between a low limit and an upper limit. The baseline operating setpoints shall be based on values determined during Testing, Adjusting and Balancing (TAB).
    - a. DP operating setpoint.
    - b. DP Low limit.
    - c. DP upper limit.
  - 4. BMS shall command DP setpoint to either increase or decrease or remain at present value.
  - 5. BMS shall poll position of all control valves every five (5) minutes.
  - 6. If any of the following are true, operating DP setpoint shall increase by 10% per polling interval until the upper limit is reached.
    - a. More than 60% of the 2-position control valves are fully open.
    - b. Any modulating control valve is 80% open or greater.
  - 7. If all of the following are true, operating DP setpoint shall decrease by 10% per polling interval until the lower limit is reached.
    - a. Less than 40% of the 2-position control valves are fully opened
    - b. All modulating control valves are less than 60% open.
  - 8. BMS shall trend the DP command setpoint and actual DP value.
  - 9. If DP value decreases 25% below the low limit or increases 25% above high limit for a period of 15 minutes, BMS shall issue alarm at the operator work station.

### 3.8 GEOTHERMAL HEATING/COOLING PLANT SYSTEMS

- A. On a call for heating at buffer tank BT-1, heat pumps HP-1 through HP-4 shall be staged on to provide hot water to maintain temperature in tank. Three way valves associated with lead heat pump shall switch to allow flow from the heat pump to BT-1. Pump HPP-1 through HPP-4 shall be staged on with associated heat pump.

- B. On a call for cooling at buffer tank BT-2, heat pumps HP-1 through HP-4 shall be staged on to provide chilled water to maintain temperature in tank. Three way valves associated with lead heat pump shall switch to allow flow from the heat pump to BT-2. Pump HPP-1 through HPP-4 shall be staged on with associated heat pump.
- C. When heat pump HP-1 through HP-4 is staged on, lead pump GWP-1 shall start and GWS&R control valve associated with respective heat pump shall open.
- D. Designation of lead and standby heat pumps shall be automatically alternated based on user defined run times or day of the week.
- E. When a heat pump is enabled, BMS shall monitor status. After an operator definable feedback time delay, if there is an indication that the heat pump is not operating, the standby heat pump shall be enabled and an alarm shall be generated.
- F. Each load and source side circulator pump shall be started by BMs and system shall allow heat pump compressors to be enabled only after flow is proven.
- G. On a call for heating or cooling at buffer tank BT-A, lead pump GLP-1 shall start. When temperature rises to 3F above setpoint or 3F below setpoint; pump shall stop.
- H. BMS shall monitor GWS&R temperature at the inlet to Tank BT-A and flow meter; and shall calculate and trend heat loss to ground and heat gain from the ground (BTUH).
- I. BMS shall monitor / display / control / trend the following points as a minimum as mapped at each heat pump through BACNET interface.
  - 1. Lead compressor and lag compressor run times.
  - 2. Temperature in and out at source side and load side.
  - 3. Trouble alarm.
  - 4. Failure alarm.
  - 5. Flow switch failure.
  - 6. (5) Other points as determined during startup and Cx.

### 3.9 AC-1 UNIT

- A. If space temperature rises above 85F, BMS shall start AC-1 fan and shall modulate chilled water valve to maintain space setpoint.
- B. BMS shall monitor leak detector in the secondary drain pan. If sensor detects leak, BMS shall shut down the AC unit and send an alarm to central PC

### 3.10 HYDRONIC HEATING UNITS

- A. Cabinet Unit Heater/Unit Heater: Upon a drop in space temperature below sensor setpoint, respective heating valve shall open and fan shall be energized subject to aquastat sensing hot water at the supply branch piping. Temp sensors shall be analog input signals to BMS. Control wiring shall be low voltage, not line voltage. Fan shall not start until aquastat senses hot water.

- B. Fin Tube Radiation: Upon a drop in space temperature below sensor setpoint, respective heating valve shall open in order to maintain desired space temperature setpoint. Radiation control for areas served by VAV boxes shall be sequenced together with the respective VAV box valve in order to maintain desired space temperature setpoint.

### 3.11 RADIANT FLOOR HEAT

- A. BMS shall monitor space temperature sensor. Upon a drop in space temperature below sensor setpoint, respective heating pump shall start.
- B. BMS shall monitor the pipe mounted temperature sensors. Upon a call for heating, BMS shall modulate respective three valve to maintain hot water supply temperature to the space. Hot water supply temperature setpoint shall be reset according to outside air. At 60F outside air temperature, hot water supply temperature shall be 85F. At 0F outside air temperature, hot water supply temperature shall be 105F.
- C. In floor space temperature sensor shall monitor for high limit. If floor temperature rises above 140F, pump shall stop and an alarm be sent to the Central PC.

### 3.12 FAN SEQUENCES OF OPERATION

- A. All Fans: BMS shall monitor the operation or failure (fan status) through a current sensing relay switch. For fans with variable frequency drives (VFD), BMS shall monitor fan status through an alarm output contact at the VFD. If fan has been signaled to start and feedback from the relay or VFD does not indicate the fan has started after 30 seconds, fan shall be shut down and an alarm shall be activated at the central PC. If damper end switches do not indicate respective dampers are open, fan shall be shut down and an alarm shall be activated at the central PC. Conversely, if status is detected while the fan is turned off or a damper is indicated open, a separate "Hand" alarm shall be generated.
- B. All fans shall be programmed to operate or allow to be operated per individual time of day program.
- C. Temperature Controls: Upon a rise in space temperature above sensor setpoint, respective fan shall start. Respective intake damper shall open (where shown on the drawings). Fan shall also be capable of being started through wall mounted switch. If switch is activated, fan shall automatically stop after 30 minutes if fan is not manually switched off.
- D. EF-3:
  - 1. Fan shall be activated per time of day when respective AHU(s) is scheduled to operate.
  - 2. BMS shall modulate the fan VFD's with a reverse acting static pressure PID to maintain the duct static pressure at the static pressure setpoint (0.8" w.c.). The operating setpoint at the pressure transmitters shall be set based on values determined during Testing, Adjusting and Balancing.
  - 3. An alarm shall be generated if the duct static pressure is 0.3" lower or higher than setpoint or is fluctuating erratically.

- E. EF-4: Associated motorized dampers shall open and respective fan(s) shall start only when switch is in the “on” position. If switch is activated, fan shall automatically stop after 30 minutes if fan is not manually switched off. Refer to interlock with AHU-2 below.
- F. GEF-1: When switch is in the “on” position, associated motorized damper shall open and respective fan shall start. If switch is activated, fan shall automatically stop after 30 minutes if fan is not manually switched off.
- G. GEF-2: When switch is in the “on” position, associated motorized damper shall open and respective fan shall start. If switch is activated, fan shall automatically stop after 30 minutes if fan is not manually switched off.

### 3.13 VAV BOXES – OCCUPANCY SENSOR

- A. Space Occupied Mode: BMS shall monitor space occupancy sensor. If sensor indicates space is occupied, respective Exhaust Air VAV boxes shall move to the maximum airflow position.
- B. Space Unoccupied Mode: BMS shall monitor space occupancy sensor. If sensor indicates space is unoccupied after a period of 10 minutes (adjustable), respective and Exhaust Air VAV boxes shall move to the minimum airflow position.
- C. BMS shall monitor airflows at each VAV box and shall adjust output signal to maintain correct airflow setting.
- D. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics. Airflow setpoints (minimum and maximum modes) shall be displayed on the graphic for each individual VAV box.

### 3.14 VAV BOXES – CONSTANT VOLUME (CV)

- A. Airflow monitoring: Pressure readings at the inlet of each VAV box shall be monitored to determine actual airflow at each box. Airflow shall be displayed at central PC graphics. Airflow setpoint shall be displayed on the graphic for each individual VAV box
- B. BMS shall modulate VAV damper position to maintain airflow setpoint.

### 3.15 AIR HANDLING UNITS (AHU) AND ENERGY RECOVERY VENTILATION (ERV) UNITS

- A. Unoccupied Mode:
  - 1. Outside air, exhaust air and relief air dampers shall be closed.
  - 2. Return air dampers shall be open.
  - 3. Fan and energy recovery motors shall be deactivated.
  - 4. When unit is signaled to stop, BMS shall slowly ramp down the fan speed. Once fans are at 10% speed, the smoke dampers (where required) shall start to close.
  - 5. BMS shall raise the zone temperature cooling setpoint to 85°F and drop the zone temperature heating setpoint of 65°F. If two or more zones are calling for

- heating or cooling the fans shall cycle on. When the call for heating or cooling is satisfied the fans shall be deactivated.
6. Chilled water and hot water valves shall be closed.
  7. Freezestat and temperature sensor within the unit's casing shall be monitored during unoccupied mode. If temperature drops below setpoint of either device, the main heating valve shall be fully open, fans shall be de-activated and an alarm shall be activated at the central PC.
  8. At units where duct mounted smoke detectors are installed outside of the envelope of the building: When unit is off or in unoccupied mode, unit shall cycle on to maintain minimum duct temperature of 40F at the duct mounted return air and supply air temperature sensors.
- B. Occupied Mode:
1. The zone will calculate how long it will take to return from its unoccupied state to its occupied setpoint based on the heating or cooling capacity and the outside air temperature. The zone will then adjust its effective setpoint at the time necessary in order to ensure the desired zone conditions at occupancy.
  2. The system will not start more than 4 hours before a scheduled occupancy.
  3. When BMS has signaled a unit to start, the smoke dampers shall open first. Once the dampers are fully open, the fans shall start.
  4. BMS shall track the supply fan's accumulated runtime. When runtime exceeds 10,000 hours, the controller will generate a runtime expiration message.
  5. Fans shall operate continuously. Speed of duplex fans shall operate in unison.
  6. Energy recovery motors shall be energized
  7. Outside air and relief air dampers shall be at minimum open positions. Coordinate setpoints of motorized dampers serving outside air and relief air dampers with air balancer.
- C. Fan Control:
1. When called to run, the fan will run for a minimum of 5 minutes.
  2. When the fan cycles off, it will remain off for a minimum of 5 minutes.
- D. Fan Control Speed:
1. BMS shall modulate the SA fan VFD(s), RA and Exhaust air fan VFD speed through VFD's to conserve energy at certain times of the day.
  2. When AHU is to be on during unoccupied times, fans shall be at 50% speed and stay at 50% if space temperature can be maintained.
  3. During periods of outdoor air at above 50F and below 85F, fans shall be at 75% speed. Oat
- E. Alarm Conditions:
1. If temperature sensors in the AHU or at duct supply air sense temperature at 40F or below, the hot water and chilled water valves at the respective unit shall be fully open, fans shall stop, outside air damper shall be fully closed and an alarm shall be activated at the central PC. Manual reset shall be possible at the graphic interface. The reset shall be locked out if it resets more than 3 times in one day or 5 times in one week.
  2. Current sensing relays/VFD feedback: If fan has been signaled to start and feedback from respective relay or VFD does not indicate the fan has started after

- 30 seconds, unit shall be shut down and an alarm shall be activated at the central PC. Conversely, if fan on status is detected while the fan is turned off, a separate "Hand" alarm shall be activated at the central PC.
  3. Damper end switches: If end switch does not indicate respective damper is open after 30 seconds, unit shall be shut down and an alarm shall be activated at the central PC. Conversely, if a damper is indicated open, a separate "Hand" alarm shall be activated at the central PC.
  4. Duct mounted smoke detectors: When a detector is in alarm mode the fire alarm system shall be notified, respective fans shall be de-energized and an alarm shall be activated at the central PC.
  5. Also refer to Alarm Section below.
- F. Supply Air Temperature Setpoint Control: BMS will run a cooling setpoint optimization algorithm and a heating setpoint optimization algorithm simultaneously.
1. The initial cooling setpoint will be 55°F, with a minimum of 53°F and a maximum of 72°F.
  2. If any sensors are still calling for cooling at the end of a 5 minute period, the setpoint algorithm will respond by lowering the setpoint by 1°F for every zone requesting cooling.
  3. If no sensors are still calling for cooling at the end of a period, the setpoint algorithm will respond by raising the setpoint by 1°F.
  4. The cooling setpoint algorithm will not adjust the cooling setpoint by more than 2°F in any period.
  5. The initial heating setpoint will be 82°F with a minimum of 72°F and a maximum of 85°F.
  6. If any sensors are still calling for heating at the end of a 5 minute period, the setpoint algorithm will respond by raising the setpoint by 2°F for every zone requesting heating.
  7. If no zones are still calling for heating at the end of a period, the setpoint algorithm will respond by lowering the setpoint by 1°F.
  8. The heating setpoint algorithm will not adjust the heating setpoint by more than 4°F in any period.
- G. Heating Control
1. If hot water is available at buffer tank, enabled, BMS will allow heating to occur.
  2. Upon a call for heating, dampers at energy recovery units shall be modulated to increase airflow rate through the energy recovery section and reduce airflow rate at the energy recovery's bypass. Energy recovery modules shall be the first stage of heating. Refer to ERV Section below.
  3. Upon a further call for heating, BMS shall modulate the hot water valve to maintain supply air temperature setpoint if cooling has been off for at least 5 minutes.
- H. Cooling Control
1. If the outside air temperature is greater than 50°F with a 2°F hysteresis and the outside air temperature is valid, the AHU controller will enable cooling based on outside air conditions.



2. If the outside air temperature reading is not valid, the AHU controller will still enable cooling.
  3. Upon a call for cooling, BMS shall modulate the chilled water valve to maintain temperature setpoints if heating has been off for at least 5 minutes.
- I. Economizer Control
1. Typical for all units.
  2. BMS will allow economizer cycles to be activated based on outside air conditions if the return air temperature and enthalpy is greater than the outside air temperature and enthalpy with a hysteresis of 5°F, the outside air enthalpy is less than 22 Btu/lb with a hysteresis of 2 Btu/lb, the outside air temperature is less than 65°F with a hysteresis of 2°F, and the outside air readings are valid.
  3. If the outside air readings are not valid, BMS will disable the economizer. The user will be able to enable the economizer if the outside air readings are not valid.
  4. When economizer cycles are activated, energy recovery motors shall stop and energy recovery bypass dampers shall open.
  5. An economizer PID will modulate the economizer/ventilation dampers and relief air/exhaust fans between minimum setpoint and 100% to maintain the zone temperature at 2°F below the zone temperature cooling setpoint if heating has been off for at least 5 minutes. The relief air fans and exhaust fans shall and activated.
    - a. The user will be able to lock the economizer damper position.
    - b. The controller will limit the signal change sent to the economizer to 1% every 2 sec. when increasing.
  6. The controller will limit the signal change sent to the economizer to 1% every 2 sec. when increasing.
  7. Through PID Loop, if the mixed air temperature drops below 45°F, the AHU controller will begin to close the economizer to protect the coil. The controller will continue to close the damper linearly until the temperature drops to 40°F, when the economizer/ventilation damper will be 100% closed.
  8. Incorporate high and low signal select algorithms between the mixed air low limit PID, temperature control PID and the DCV PID.
  9. If the AHU loses flow or the freezestat trips, the AHU controller will close the economizer dampers.
  10. The AHU controller will generate an alarm if the mixed air temperature remains lower than 45°F for 5 minutes with a 5°F hysteresis. This alarm will not be enabled until the supply fan has been running for 30 minutes.
  11. The AHU controller will generate an alarm if the mixed air temperature remains higher than 90°F for 5 minutes with a 5°F hysteresis. This alarm will not be enabled until the supply fan has been running for 30 minutes.
- J. Air Flow Monitoring Stations (AFMS)
1. Calibration of flow rates at all AFMS shall be based on values determined during Testing, Adjusting and Balancing (TAB).
  2. All AFMS shall be monitored and data recorded independently.



- K. Outside Air – Demand Control Ventilation
  - 1. BMS shall monitor airflow (cfm) at the outside air AFMS and shall modulate the outside air (OA) and return air (RA) dampers to maintain outside air flow rate setpoint.
  - 2. If economizer mode is not enabled, dampers shall modulate between minimum OA flow rate and maximum OA flow rate.
  - 3. Through PID loop, BMS shall modulate OA damper to maintain maximum 700 ppm carbon dioxide levels (CO<sub>2</sub>) at any associated CO<sub>2</sub> sensor. If CO<sub>2</sub> levels are approaching 700 ppm, BMS shall modulate the OA damper(s) open. If CO<sub>2</sub> levels are approaching 600 ppm the BMS shall modulate the OA damper(s) closed.
  - 4. If CO<sub>2</sub> levels rise above 770 ppm at any sensor, an alarm shall be sent to the central workstation.
  
- L. Dehumidification
  - 1. BMS shall monitor humidity in the spaces served by these units. If the humidity rises above 60% RH, BMS shall modulate respective chilled water valve to maintain humidity below setpoint.
  - 2. When in dehumidification mode of operation, if the space temperature drops below setpoint, BMS shall modulate respective hot water valve to maintain space temperature.
  
- M. Trombe Wall Return Air at AHU-3 and AHU-4
  - 1. RA duct from Trombe wall shall serve AHU-3 and AHU-4.
  - 2. If either AHU is in heating mode and the space temperature in the Trombe wall is higher than the temperature in the RA duct, the RA damper serving the Trombe wall shall open and the RA damper serving the space shall close.

### 3.16 ERV UNITS

- A. In addition to the Sequences of Operation listed above, DOAS and ERV Units shall incorporate the following:
  
- B. Unoccupied mode: the supply fan shall cycle as needed to maintain the setback temperature and the recirculation damper shall open. The unit shall operate as a 100% recirculating unit unless the outdoor conditions are appropriate for economizer.
  
- C. Stage 1 Free Heat:
  - 1. If the outside air temperature is lower than the return air temperature the BMS shall allow energy recovery.
  - 2. The energy recovery wheel shall be enabled.
  - 3. The outside air (wheel) bypass damper and the exhaust air (wheel) bypass damper shall modulate so as to maintain the discharge air temperature setpoint.
  - 4. The hot water control valve shall modulate closed.
  
- D. Stage 2 Heating:
  - 1. The energy recovery wheel shall be enabled.
  - 2. The outside air (wheel) bypass damper shall close.

3. The exhaust air (wheel) bypass damper shall close.
  4. The heating controls shall be activated as described above.
- E. Energy Wheel Frost Protection Control
1. To prevent frost build up on the wheel, the BMS shall monitor the outside air temperature. If the entering outside air temperature is less than the "Frost Control Setpoint" as established by the energy wheel's manufacturer, The BMS shall initiate "De-Frost Mode".
  2. The energy recovery wheel shall be enabled.
  3. The exhaust air (wheel) bypass damper shall be closed.
  4. The outside air (wheel) bypass damper shall modulate to ensure that the exhaust air temperature is at or above the frost control setpoint.
  5. The heating controls shall be activated as described above.
- F. Cooling Mode with Energy Recovery
1. If the outside air temperature is greater than the economizer changeover setpoint and the outside air temperature is greater than the return air temperature the BMS shall allow energy recovery.
  2. The energy recovery wheel shall be enabled.
  3. The outside air (wheel) bypass damper shall close.
  4. The exhaust air (wheel) bypass damper shall close.
  5. The recirculation damper shall modulate to its corresponding position.
  6. The cooling controls shall be activated as described above.

### 3.17 AHU-2 SERVING LAB

- A. In addition to the Sequences of Operation listed above, AHU-2 shall incorporate the following listed below:
- B. AHU-2 fans shall start (and stop) per occupancy sensors.
- C. If switch for hood exhaust fan EF-4 is activated, OA damper shall be at position to provide 650 cfm OA. AHU-2 exhaust fan shall be off and ER wheel shall not be operating
- D. Space shall be served by a labeled "VM" selector switch on the wall to provide the user different Ventilation Modes of operation. Change between modes of operation shall be manual.
  1. Energy Saving Mode (Standard Ventilation Rate): Outside air damper shall be at minimum flow position, AHU-2 exhaust fan shall be off and ER wheel shall not be operating.
  2. Maximum Ventilation Mode: Outside air and exhaust dampers shall be at 100% open position, AHU-2 SA and exhaust fans shall be at 100% speed and ER wheel shall not be operating per SOP above After 30 minutes, if switch is not changed back to Energy Saving Mode, BMS shall automatically change the operation back to Energy Saving Mode.

3.18 NATURAL VENTILATION AT OPEN OFFICE

- A. Trombe Wall: When signaled by the BMS, the users shall open the dampers at the roof hoods at the Trombe wall by manually activating a switch located in the space.
- B. Windows: When signaled by the BMS, the users shall manually open windows and open mechanized windows by manually activating a switch located in the space. Refer to electrical drawings.

3.19 MONITORING OF OUTDOOR AIR CONDITIONS

- A. Functional Control
  - 1. The controller shall monitor outside air temperature and humidity and calculate the outside air enthalpy. These readings and values shall be available to the system.
- B. Temperature, Humidity and Carbon Dioxide History: BMS shall record data as follows:
  - 1. Daily high and low readings: At 12:05 am every night, the controller shall reset the high and low daily peak recordings for the next day.
  - 2. Monthly high and low readings: At 12:05 am on the first day of each month, the controller shall reset the high and low monthly peak recorders for the next month.
  - 3. Yearly high and low readings: At 12:05 am on the first day of each year, the controller shall reset the high and low yearly peak recorders for the next year.

3.20 DASHBOARD

- A. BMS contractor shall be responsible for purchasing and installing the dashboard screen, accessories, mounting hardware, software and programming as described below.
- B. Interaction with dashboard shall through touch screen and mouse.
- C. The following graphics shall be on display on the Dashboard. Graphics shall be developed and generated by BMS contractor. Ten graphic displays shall be generated. Dashboard shall scroll between graphic displays every 2 minutes, but can be paused by a visitor to the Lobby. If paused, graphics will start to scroll again after 2 minutes. Graphics generated shall be:
  - 1. Geothermal piping loop diagram specific to the project including energy generated in BTUH to date. BTUH data graphic shall be updated every time display is regenerated
  - 2. Photovoltaic display can be specific to the project or generic and shall show electricity generated in KW to date. KW data graphic shall be updated every time display is regenerated.
  - 3. Building construction graphic including wall panels, roof panels, insulation, vapor barrier, etc.
  - 4. Site selectin for building; north side underground and south side facing sun with overhang.
  - 5. Trombe wall graphic showing benefits for winter and summer natural ventilation.
  - 6. Typical air handing unit layout and function including ERV features.
  - 7. In floor radiant heat.

- 8. Use of windows for natural ventilation and expanded temperature control before starting AC.
  - 9. Lighting and controls.
  - 10. Use of occupancy sensors for lighting, power and ventilation.
- D. Dashboard programming shall be expandable to add 20 more displays in the future.

### 3.21 UTILITY METERING

- A. BMS shall monitor the electric meters and water meters. For Specification of meters refer to Division 26 and Division 22 specifications respectively.
- B. BMS shall trend and store data and save usage of electricity in KWH and water in GPM. Usage shall be saved in 10 minute increments. Also refer to Trending Paragraph below.
- C. Usage shall be recorded in a spread sheet format (either an XCEL spread sheet, “.csv file format” or other spread sheet format as approved by Owner. Spread sheet shall show usage of each meter by day and compiled for each month and each year. Also, provide chart to have visual indication of usage throughout the year. Format of spread sheet and chart shall be reviewed and approved by Owner.

### 3.22 DEMAND RESPONSE – LOAD SHEDDING

- A. BMS shall monitor signal from Eversource to signal BMS to reduce electrical usage within a specific time frame (generally 12 to 24 hour notice).
- B. When signaled, BMS shall reduce air conditioning load in the building by:
  - 1. Closing chilled water valves at specific AHU’s (spaces will then not be air conditioned).
  - 2. Setting space temperature higher for the remaining spaces.
  - 3. Limiting the quantity of heat pumps that can operate.

### 3.23 TRENDING

- A. BMS contractor shall be responsible for setting up all trends as listed here-in. Trending shall not occur through use of licensing through 3<sup>rd</sup> party software.
- B. The following items shall be linked to a trend log. BMS shall record a trend sample every 10 minutes for all items listed below.
  - 1. All input and output (I/O) points
  - 2. All calculated values and variables (i.e. enthalpy, differential pressures, reset setpoints, BTUH usage, etc.).
  - 3. Who logs in and how long they were logged in.
  - 4. When logged in, record the changes made by person logged in.
- C. For the first 5 years of operation, the system shall trend and record all data at 10 minute increments. Data shall be saved permanently on the local hard drive with shall automatically backup every day to the Owner’s remote servers.

- D. Indoor and Outdoor Environmental Log: A dedicated trend log page shall be setup to permanently monitor and record all indoor and outdoor conditions as follows (per State of CT HPB requirements):
  - a. Temperature at all outdoor sensors.
  - b. Temperature at all indoor space sensors.
  - c. Relative humidity and dew point temperature at indoor and outdoor space sensors.
  - d. CO2 at all indoor and outdoor space sensors.

### 3.24 ALARM NOTIFICATION

- A. BMS contractor shall be responsible for setting up all alarms as listed here-in. Software and programming shall not occur through use of licensing through 3<sup>rd</sup> party software.
- B. All alarms shall be listed on a graphics page dedicated to alarms (“Alarm Log Page”) which shall list all alarms by “Level of Alarm”. Listing at the Alarm Log Page shall describe:
  - 1. Specific input signal that is in alarm.
  - 2. Date and time when the alarm first started.
  - 3. Setpoint and actual reading at the time of the alarm.
  - 4. Indication if the device is still in alarm mode.
  - 5. How many times a specific device has been in alarm over the entire history.
- C. All alarms shall be cleared at the Alarm Log Page through a graphic interface.
- D. All alarms shall be permanently recorded and stored. A history of all alarms shall be available to the user; and shall be sorted, searched and saved by date and by type of alarm.
- E. Equipment Graphic Alarm: Certain alarms as listed below shall be indicated on the respective “Equipment Graphics Page”. These graphic displays shall indicate an alarm condition by showing the appropriate object in red and blinking.
- F. All alarms shall be classified as Level 1, Level 2 or Level 3.
- G. Level 1 Alarm: Following shall occur:
  - 1. Alarm shall be displayed at “Alarm Log Page”.
  - 2. Alarm history shall be trended and permanently saved.
  - 3. Send text messages.
  - 4. Send email messages.
  - 5. Warning of new Level 1 Alarms shall be displayed when user first logs into software.
  - 6. Equipment Graphic Alarm shall occur.
- H. Level 2 Alarm: Following shall occur:
  - 1. Alarm shall be displayed at “Alarm Log Page”.
  - 2. Alarm history shall be trended and permanently saved.
  - 3. Equipment Graphic Alarm shall occur.

- I. Level 3 Alarm: Following shall occur:
    - 1. Alarm shall be displayed at “Alarm Log Page”.
    - 2. Alarm history shall be trended and permanently saved.
  
  - J. Contractor shall coordinate with the Owner with programming alarms including off site alarms such as text messages; and trouble shooting them for accuracy.
- 3.25 POST CONSTRUCTION MONITORING (IN COMPLIANCE WITH MONITORING BASED COMMISSIONING REQUIREMENTS)
- A. BMS shall constantly monitor all input signals (analog and digital).
  
  - B. All input signals and calculated values and variables shall have parameters that can create an alarm; and shall be classified by one of the three alarm levels as listed below.
  
  - C. Level 1 Alarm: If a device is in alarm, the alarm condition listed above shall occur. The following devices and setpoints shall generate a Level 1 Alarm:
    - 1. Space temperature above or below setpoint by 3F for minimum 15 minute period of time unless noted otherwise.
    - 2. Humidity at any humidity sensor above setpoint by 5% RH for minimum 15 minute period of time unless note otherwise.
    - 3. Pressure at duct mounted pressure transmitter is 0.2” above setpoint for minimum 15 minute period and fan speed is not at minimum VFD setting
    - 4. Fan not operating when called to be active.
    - 5. Loss of communications: When a controller has established communication with the system after any interruption in communication, it will record a temperature and humidity history for the system.
    - 6. Compare outdoor readings between (2) temperature and (2) humidity sensors.
    - 7. Discrepancy of more that 2F and 5%RH for minimum 15 minute period at outdoor readings for (2) temperature and (2) humidity sensors.
    - 8. Outdoor airflow value varies by 10% or more from the outdoor airflow setpoint.
  
  - D. Level 2 Alarm: If a device is in alarm, the alarm condition listed above shall occur. The following devices and setpoints shall generate a Level 2 Alarm:
    - 1. Differential pressure at filter DPT’s is above setpoint.
  
  - E. Level 3 Alarm: If a device is in alarm, the alarm condition listed above shall occur. The following devices and setpoints shall generate a Level 3 Alarm:
    - 1. Humidity at duct mounted sensor at discharge of each AHU is above setpoint by 5% RH for minimum 15 minute period of time.
- 3.26 COMMISSIONING
- A. Engage a factory-authorized service representative, to perform startup service as per functional test sheets and requirements of Section 23 08 00.
  
  - B. Verify that equipment is installed and commissioned as per requirements of Section 23 08 000 and manufacturer's written instructions.

- C. Complete installation and startup checks and functional tests according to Section 23 08 00 and manufacturer's written instructions.
- D. Operational Test: After electrical and control systems have been energized, start units to confirm proper unit operation. Rectify malfunctions, replace defective parts with new one and repeat the start up procedure.
- E. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

END OF SECTION 230993

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SECTION 232113 - HYDRONIC PIPING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Heating hot water piping.
2. Chilled water piping.
3. Ground water piping in building.
4. Radiant floor piping.
5. No potable cold water.
6. Equipment drains and over flows.
7. Unions and flanges.

B. Related Sections:

1. Section 07 84 00 - Firestopping: Product requirements for firestopping for placement by this section.
2. Section 08 31 13 - Access Doors and Frames: Product requirements for access doors for placement by this section.
3. Section 09 90 00 - Painting and Coating: Product requirements Painting for placement by this section.
4. Section 23 04 00 – General Conditions for Mechanical Trades
5. Section 23 05 00 – Common Work Results for HVAC
6. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping: Product and execution requirements for expansion compensation devices use in heating and cooling piping systems.
7. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves for placement by this section.
8. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for pipe hangers and supports, sleeves, and firestopping for placement by this section.
9. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment: Product requirements for Vibration Isolation for placement by this section.
10. Section 23 07 00 - HVAC Insulation: Product requirements for Piping Insulation for placement by this section.
11. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties used in heating and cooling piping systems.
12. Section 23 21 23 - Hydronic Pumps: Product and execution requirements for pumps used in heating and cooling piping systems.
13. Section 23 25 00 - HVAC Water Treatment: Product and execution requirements for cleaning and chemical treatment of heating and cooling piping systems.
14. Section 322313 – Geothermal Energy Exchange Wells.

## 1.2 REFERENCES

- A. American Society of Mechanical Engineers:
1. ASME B16.3 - Malleable Iron Threaded Fittings.
  2. ASME B16.4 - Gray Iron Threaded Fittings.
  3. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
  4. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
  5. ASME B31.1 - Power Piping.
  6. ASME B31.9 - Building Services Piping.
  7. ASME Section IX - Boiler and Pressure Vessel Code - Welding and Brazing Qualifications.
- B. ASTM International:
1. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
  2. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
  3. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
  4. ASTM A536 - Standard Specification for Ductile Iron Castings.
  5. ASTM B32 - Standard Specification for Solder Metal.
  6. ASTM B88 - Standard Specification for Seamless Copper Water Tube.
  7. ASTM B584 - Standard Specification for Copper Alloy Sand Castings for General Applications.
  8. ASTM D1785 - Standard Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
  9. ASTM D2466 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
  10. ASTM D2564 - Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
  11. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers.
  12. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications.
- C. American Welding Society:
1. AWS A5.8 - Specification for Filler Metals for Brazing and Braze Welding.
  2. AWS D1.1 - Structural Welding Code - Steel.
- D. American Water Works Association:
1. AWWA C105 - American National Standard for Polyethylene Encasement for Ductile-Iron Pipe Systems.
  2. AWWA C110 - American National Standard for Ductile-Iron and Grey-Iron Fittings, 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.

3. AWWA C111 - American National Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
  4. AWWA C151 - American National Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
- E. Manufacturers Standardization Society of the Valve and Fittings Industry:
1. MSS SP 58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.
  2. MSS SP 67 - Butterfly Valves.
  3. MSS SP 69 - Pipe Hangers and Supports - Selection and Application.
  4. MSS SP 70 - Cast Iron Gate Valves, Flanged and Threaded Ends.
  5. MSS SP 71 - Cast Iron Swing Check Valves, Flanged and Threaded Ends.
  6. MSS SP 78 - Cast Iron Plug Valves, Flanged and Threaded Ends.
  7. MSS SP 80 - Bronze Gate, Globe, Angle and Check Valves.
  8. MSS SP 85 - Cast Iron Globe & Angle Valves, Flanged and Threaded.
  9. MSS SP 89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
  10. MSS SP 110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate layout of piping system, including equipment, critical dimensions, and sizes.
- C. Product Data:
  1. Piping: Submit data on pipe materials, fittings, and accessories. Submit manufacturers catalog information.
  2. Valves: Submit manufacturers catalog information with valve data and ratings for each service.
  3. Hangers and Supports: Submit manufacturers catalog information including load capacity.
- D. Test Reports: Indicate results of piping system pressure test.
- E. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures and isolation.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- G. Welders' Certificate: Include welders' certification of compliance with ASME Section IX and AWS D1.1.

### 1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of valves, equipment and accessories.

- C. Operation and Maintenance Data: Submit instructions for installation and changing components, spare parts lists, exploded assembly views.
- 1.5 QUALITY ASSURANCE
- A. Perform Work in accordance with ASME B31.1 and ASME B31.9 code for installation of piping systems and ASME Section IX for welding materials and procedures.
  - B. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
  - B. Fabricator or Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum two weeks prior to commencing work of this section.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
  - B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
  - C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
  - D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the Work, and isolating parts of completed system.
- 1.9 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.

## PART 2 PRODUCTS

### 2.1 HEATING HOT WATER PIPING, CHILLED WATER PIPING, GROUND WATER PIPING AND NON POTABLE COLD WATER IN THE BUILDING (ABOVE GRADE)

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black.
  - 1. Fittings (150 lb rating): ASME B16.3, malleable iron or ASTM A234/A234M, carbon steel welding type, long radius type. Tees and fittings shall be prefabricated except Weldolet type fittings may be used where branch line is less than ½ the size of the main. Reducers shall be eccentric
  - 2. Joints: Threaded for pipe 2 inch and smaller; welded or flanged for pipe 2-1/2 inches and larger.
  - 3. Flanges: Class 150 socket or welding neck type with raised face and spiral serrated finish conforming to ASTM A105. Gaskets shall be red rubber wire reinforced. Bolts shall be unfinished square head machine bolts conforming to ASTM A307
  - 4. Mechanical couplings for steel piping shall not be used.
  
- B. Copper Tubing: ASTM B88, Type L, drawn.
  - 1. Fittings: ASME B16.22 solder wrought copper.
  - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
  
- C. Copper Tubing ASTM B88, Type L, drawn.
  - 1. Fittings: ASME B16.22 wrought copper with EPDM sealing element and press end type, fitting bead collars.
  - 2. Joints: Mechanically connected with crimping tool.
  - 3. EPDM sealing element shall be compatible with hydronic systems operating with 100% water and systems operating with partial propylene glycol and water solutions.

### 2.2 CONDENSATE DRAINS

- A. Copper Tubing: ASTM B88, Type L drawn.
  - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
  - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
  
- B. Copper Tubing (up to and including 2" diameter) ASTM B88, Type L, drawn.
  - 1. Fittings: ASME B16.22 wrought copper with EPDM sealing element and press end type, fitting bead collars.
  - 2. Joints: Mechanically connected with crimping tool.
  - 3. EPDM sealing element shall be compatible with hydronic systems operating with 100% water and systems operating with partial propylene glycol and water solutions.

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## 2.3 EQUIPMENT DRAINS, PRESSURE RELIEFS AND OVERFLOWS

- A. Steel Pipe: ASTM A53/A53M Schedule 40, galvanized.
  - 1. Fittings: ASME B16.3, malleable iron or ASME B16.4, cast iron.
  - 2. Joints: Threaded for pipe 2 inch and smaller; flanged for pipe 2-1/2 inches and larger.
- B. Copper Tubing: ASTM B88, Type L drawn.
  - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
  - 2. Joints: Solder, lead free, ASTM B32, 95-5 tin-antimony, or tin and silver, with melting range 430 to 535 degrees F.
- C. Copper Tubing (up to and including 2" diameter) ASTM B88, Type L, drawn.
  - 1. Fittings: ASME B16.22 wrought copper with EPDM sealing element and press end type, fitting bead collars.
  - 2. Joints: Mechanically connected with crimping tool.
  - 3. EPDM sealing element shall be compatible with hydronic systems operating with 100% water and systems operating with partial propylene glycol and water solutions.

## 2.4 UNIONS AND FLANGES

- A. Unions for Pipe 2 inches and Smaller:
  - 1. Ferrous Piping: Class 150, malleable iron, threaded.
  - 2. Copper Piping: Class 150, bronze unions with soldered.
  - 3. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end, water impervious isolation barrier.
  - 4. PVC Piping: PVC.
- B. Flanges for Pipe 2-1/2 inches and Larger:
  - 1. Ferrous Piping: Class 150 forged steel, slip-on flanges.
  - 2. Copper Piping: Class 150, slip-on bronze flanges.
  - 3. PVC Piping: PVC flanges.
  - 4. Gaskets: 1/16 inch thick preformed neoprene gaskets.

## 2.5 RADIANT FLOOR HEATING PIPING (BELOW SLAB AND SPECIALTIES)

- A. Pipe Material:
  - 1. PEX tubing and fittings shall maintain a quality control program in accordance with ISO 9001 or NSF International in the manufacturing plant to assure that the tubing and fittings are continually being produced to the required standard.
  - 2. Tubing shall be silane cross-linked high density polyethylene as per ASTM F876/F877 and CSA B137.5.
  - 3. Tubing includes four layers.
    - a. First layer: Cross-linked, high density polyethylene.
    - b. Second layer: Adhesive.
    - c. Third layer: Ethylene vinyl alcohol layer (EVOH oxygen barrier).
    - d. Fourth layer: Polyethylene to protect the EVOH layer from damage.
  - 4. Certified to NSF 14 and 61.

5. Tubing will have 6 month UV protection.
- B. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
- C. Bronze Fittings: PEX Press Fittings manufactured from copper alloy, meeting the requirements of ASTM F 877 tested as a system with PEX Barrier tubing.
  1. PEX Press Sleeve: Manufactured out of a 304 grade or better stainless steel, and have one view hole (loose sleeve) or three view holes (attached sleeve) to ensure proper PEX tubing insertion.
  2. Attached sleeve fitting will incorporate a tool locator ring that shall be in place while making a proper press connection.
  3. PEX press connection shall be made with a PEX Press power tool.
- D. Pressure/Temperature Rating: Cross-linked polyethylene tubing shall meet the standard grade hydrostatic pressure ratings from the Plastic Pipe Institute in accordance with TR-4/03. The following three ratings are required:
  1. 200F at 80 psi.
  2. 180F at 100 psi.
  3. 73.4F at 160 psi.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.

#### 3.2 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

#### 3.3 INSTALLATION – GENERAL REQUIREMENTS

- A. Where more than one piping system material is specified, provide compatible system components and joints. Use non-conducting dielectric connections whenever jointing dissimilar metals in open systems.
- B. Provide flanges, union, and couplings at locations requiring servicing. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.

- C. Flexible Connectors: Use at or near pumps and equipment connections where piping configuration does not absorb vibration.

#### 3.4 INSTALLATION - ABOVE GROUND PIPING SYSTEMS

- A. Install in accordance with manufacturer's instructions.
- B. Install piping in accordance with ASME B31.9.
- C. Route piping parallel to building structure and maintain gradient.
- D. Install piping to conserve building space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls and floors.
- G. Install firestopping at fire rated construction perimeters and openings containing penetrating sleeves and piping. Refer to Section Division 7.
- H. Install pipe identification in accordance with Section 23 05 00.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
- J. Provide access where valves and fittings are not exposed. Coordinate size and location of access doors with Division 8.
- K. Slope hydronic piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe aligned. Provide 3/4" drain valves with hose and connections at all low points, bases of vertical risers, main shut-off valves and at equipment
- L. Provide manual air vents at all system high points. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- M. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- N. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 9.
- O. All strainer blow-down connections shall be provided with a 3/4" drain valve with hose connection and brass cap.
- P. PVC and ABS piping shall not be installed.
- Q. Coil Condensate Drains: Provide pipe trap at all cooling coil drain pans. Pipe to nearest drain at 1/4" per foot pitch.



- R. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 00.
- S. Insulate piping; refer to Section 23 07 00.
- T. Glycol/water solutions: Upon completion of flushing and testing of the system, all piping and equipment shall be drained to ensure a proper propylene glycol/water mixture. Blow out piping and equipment with air as required to remove all water from system.

### 3.5 INSTALLATION – PRESS STYLE FITTINGS

- A. Press connections: Copper and copper alloy press connections shall be made in accordance with the manufacturer's installation instructions. The tubing shall be fully inserted into the fitting and the tubing marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the tubing to assure the tubing is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) recommended by the manufacturer. Contractor shall be trained on the use and installation of the system by manufacturer's representative.
- B. Pressure test to identify un-pressed fittings: Utilizing air or water, the system shall be pressurized, not to exceed 85 psi. If there is a significant drop in pressure, the system shall be walked to check for un-pressed fittings. Should an un-pressed fitting be located, the pressure should be released from the system and the un-pressed fitting shall be pressed. If no un-pressed fitting is identified the system shall be pressurized to test pressures required by code, not to exceed 600 psi.

### 3.6 CLEANING, FLUSHING, AIR PURGING AND WATER TREATMENT

- A. Upon completion of all work, all piping systems shall be flushed with water or liquid alkaline solution with emulsifying agents and detergents, to remove dirt, grease, grit, chips and foreign matter.
- B. Solution for flushing shall be used in sufficient quantity to produce a velocity of at least 2.5 feet per second. Flushing shall continue until discharge solution shows no discoloration or evidence of foreign materials.
- C. During flushing operation, all valves shall be operated several times, bypasses opened, pumps operated and equipment flushed.
- D. Upon completion of flushing operations, all strainers, filters and blowdowns shall be removed and cleaned of accumulated waste.
- E. Systems with propylene glycol solutions: Upon completion of flushing and testing, all piping and equipment shall be drained to ensure a proper propylene glycol/water mixture. Blow out piping and equipment with air as required to remove all water from system.
- F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00.
- G. Purge air from system.

- H. Geothermal Energy Exchange Wells Contractor (Spec Section 332313) and “Building Contractor” (Spec Section 232112) shall be both responsible for the entire combined system including all piping on site, piping in bores and piping at interior of the building (all piping at the load side of the heat pumps to and including the bore fields). Both contractors shall be responsible for cleaning, flushing, air purging and water treatment of the entire system.
- 3.7 TESTING
- A. All piping systems installed under this Contract shall be pressure tested with clean, clear water to insure tightness.
- B. Contractor shall be responsible for furnishing all plugs, piping, valves, hoses, and pumps necessary for required tests and for proper disposal of the water upon completion of the tests. All lines shall be thoroughly cleaned before testing.
- C. Items which are not to be subjected to the hydrostatic test shall be either removed or blanked off. Short sections of piping which must be removed to permit the installation of blinds or blanks must be tested separately.
- D. The test pump hook-up for hydrostatic test shall be such that the pressure may be applied gradually under perfect control. A valve shall be provided for blocking in the piping during the test period. The systems should be filled with water thru a low connection point, care being taken that air is completely vented so that there are no air pockets remain. The pressure shall be applied gradually and held at the specified value for the time required to visually check each weld, connection, joint, flange, etc., but not less than a minimum of two hours. Test readings may be taken at the lowest point of the line or system of lines providing static head is added to the minimum hydrostatic test pressure. Care shall be taken to insure that at no point a dangerous over-pressure is experienced.
- E. The hydrostatic test shall be considered satisfactory if no visible leakage, cracks or other signs of distress are discovered on the piping or at any joints. There is no requirement for minimum pressure drop during the test period; however, the cause of any pressure loss other than that due to temperature change or similar reasons shall be justified to the satisfaction of the Owner’s representative.
- F. Minor leaks in screwed or flanged joints may be repaired without retesting subject to the approval of the Owner.
- G. After completion of the hydrostatic testing, the system shall be completely drained at all low points. All test blinds, temporary supports, test equipment, etc., shall then be removed, and any valves, orifice plates, short sections of piping, miscellaneous in-line equipment or instruments that were left ready for service. New gaskets shall be used when re-installing flanged items.
- H. If there is any danger of contamination or freezing, blow out the piping system with dry, oil-free air as necessary.

- I. At completion of tests Contractor shall submit a typewritten log of test data for Owner's permanent file including:
    - 1. Data of test.
    - 2. Section tested-attach sketch.
    - 3. Equipment used.
    - 4. Personnel involved.
    - 5. Owner or Owner's witness in attendance.
    - 6. Results.
  
  - J. After repair any failed test shall be repeated until all requirements of this Section are met.
  
  - K. Test Pressures:
    - 1. All piping systems unless notes otherwise shall be tested at 100 psig or 1.5 times the operating pressure, whichever is greater.
    - 2. Cooling coil condensate drain piping shall be tested at 10 ft head.
- 3.8 INSTALLATION - BURIED PIPING SYSTEMS
- A. Verify excavations are to required grade, dry, and not over-excavated.
  
  - B. Establish minimum separation to other services.
  
  - C. Remove scale and dirt on inside of piping before assembly.
  
  - D. Place bedding material to provide uniform bedding for piping, level bedding materials in one continuous layer.
  
  - E. Route pipe in straight line.
  
  - F. Pipe Cover and Backfilling:
    - 1. Maintain optimum moisture content of fill material to attain required compaction density.
    - 2. After hydrostatic test, evenly backfill by hand placing backfill material and hand tamping in compacted layers to
    - 3. Evenly and continuously backfill remaining trench depth in uniform layers with backfill material.

END OF SECTION 232113

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SECTION 232116 HYDRONIC PIPING SPECIALTIES

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pressure gages.
2. Thermometers.
3. Test plugs.
4. Flow indicator (bullet type).
5. Diaphragm-type expansion tanks.
6. Buffer tanks.
7. Air vents.
8. Air separators.
9. Strainers.
10. Pump suction fittings.
11. Combination pump discharge valves.
12. Relief valves.
13. Manual balancing valves.
14. Autoflow / automatic balancing valves.

B. Related Sections:

1. Section 23 04 00 – General Conditions for Mechanical Trades
2. Section 23 21 13 - Hydronic Piping: Execution requirements for piping connections to products specified by this section.
3. Section 23 21 23 - Hydronic Pumps: Execution requirements for piping connections to products specified by this section.

1.2 REFERENCES

A. American Society of Mechanical Engineers:

1. ASME B40.1 - Gauges - Pressure Indicating Dial Type - Elastic Element.
2. ASME Section VIII - Boiler and Pressure Vessel Code - Pressure Vessels.

B. ASTM International:

1. ASTM E1 - Standard Specification for ASTM Thermometers.
2. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers.

C. Underwriters Laboratories Inc.:

1. UL 393 - Indicating Pressure Gauges for Fire-Protection Service.
2. UL 404 - Gauges, Indicating Pressure, for Compressed Gas Service.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit for manufactured products and assemblies used in this Project.
  - 1. Manufacturer's data and list indicating use, operating range, total range, accuracy, and location for manufactured components.
  - 2. Submit product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
  - 3. Submit schedule indicating manufacturer, model number, size, location, rated capacity, load served, and features for each piping specialty.
  - 4. Submit electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures, application, selection, and hookup configuration. Include pipe and accessory elevations.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of actual locations of components and instrumentation.
- C. Operation and Maintenance Data: Submit instructions for calibrating instruments, installation instructions, assembly views, servicing requirements, lubrication instruction, and replacement parts list.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

1.6 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept piping specialties on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Protect systems from entry of foreign materials by temporary covers, caps and closures, completing sections of the work, and isolating parts of completed system until installation.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install instruments when areas are under construction, except rough in, taps, supports and test plugs.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements before fabrication.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 PRESSURE GAGES AND TAPS

- A. Manufacturers:
  - 1. Trerice 600 Series or approved equal by:
  - 2. Ernst.
  - 3. Davis
- B. Gage: ASME B40.1, UL 393 or UL 404 with bourdon tube, rotary brass movement, brass socket, front calibration adjustment, black scale on white background, clear glass window.
  - 1. Case: Cast aluminum.
  - 2. Bourdon Tube: Brass.
  - 3. Dial Size: 3-1/2 inch diameter.
  - 4. Mid-Scale Accuracy: One percent.
  - 5. Scale: Both psi and kPa.

- C. Needle Valve or Ball Valve: Brass, 1/4 inch NPT for minimum 250 psi.
- D. Pulsation Damper: Pressure snubber, brass with 1/4 inch NPT connections.
- E. Siphon: Brass 1/4 inch NPT angle or straight pattern.

## 2.2 STEM TYPE THERMOMETERS

- A. Manufacturers:
  - 1. Terrice B91 Series or approved equal by:
  - 2. Ernst
  - 3. Davis Model
- B. Thermometer: ASTM E1, adjustable angle, red appearing mercury, lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device.
  - 1. Size: 9 inch scale.
  - 2. Window: Clear glass.
  - 3. Stem: Brass, 3/4 inch NPT, 3-1/2 inch long.
  - 4. Accuracy: ASTM E77 2 percent.
  - 5. Calibration: Both degrees F and degrees C.
- C. Socket: Brass separable sockets for thermometer stems with or without extensions.

## 2.3 TEST PLUGS

- A. Manufacturers:
  - 1. Omega
  - 2. Imac
  - 3. Peterson
- B. 1/4 inch NPT or 1/2 inch NPT brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with:
  - 1. Neoprene core for temperatures up to 200 degrees F.
  - 2. Nordel core for temperatures up to 350 degrees F.
  - 3. Viton core for temperatures up to 400 degrees F.

## 2.4 AIR VENTS

- A. Manufacturers:
  - 1. Taco
  - 2. B+G.
  - 3. Amtrol.
- B. Manual Type: Taco Model 417 combination manual/automatic, Nickel plated brass body with hydroscopic fiber discs, screwed fitting and slotted/threaded venting.



- C. Float Type: B+G Model 87, brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

## 2.5 FLOW INDICATOR (BULLET OR IMPELLER TYPE)

- A. Manufacturers:
  - 1. Dwyer
  - 2. Cole Parmer.
  - 3. W.E. Anderson
- B. Paddle wheel with double window. Body shall be brass or carbon steel body.

## 2.6 STRAINERS

- A. Manufacturers:
  - 1. Spirax Sarco Models listed below or approved equal by:
  - 2. Armstrong.
  - 3. Yarway.
- B. Size 2 inch and Under: Screwed cast iron body for 175 psig working pressure, Y pattern with 1/32" stainless steel perforated screen. Spirax Sarco Model IT.
- C. Size 2-1/2 inch and Larger: Flanged iron body for 150 psig working pressure, basket pattern with 3/64" screen for size up to 4", 1/8" screen for 4" and larger; stainless steel perforated screen. Spirax Sarco Model F-125.

## 2.7 RELIEF VALVES

- A. Manufacturers:
  - 1. B+G Safety Relief Valve or approved equal by:
  - 2. Watts.
  - 3. Taco.
  - 4. Parker Hannifin.
- B. Brass body, Teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled. Provide with drip pan elbow at outlet.
- C. Bronze body, Teflon seat, stem and springs, automatic, direct pressure actuated capacities ASME certified and labeled.

## 2.8 DIAPHRAGM-TYPE EXPANSION TANKS

- A. Manufacturers:
  - 1. Armstrong S series listed below or approved equal by:
  - 2. Taco
  - 3. B+G:
- B. Tanks shall be vertical, floor mounted.

- C. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig, with flexible butyl diaphragm sealed into tank and steel support stand.
- D. Accessories: Pressure gage and air-charging fitting, tank drain; pre-charge to 12 psig.
- E. ET-1 shall be L Series; tank volume shall be 80 gallons with acceptance volume of 80 gallons.
- F. ET-2 shall be AX Series; tank volume shall be 44 gallons with acceptance volume of 22 gallons.
- G. ET-3 shall be AX Series; tank volume shall be 22 gallons with acceptance volume of 11 gallons.
- H. GLET-1 shall be L Series; tank volume shall be 158 gallons with acceptance volume of 158 gallons.

## 2.9 BUFFER TANKS

- A. Manufacturers:
  - 1. Niles Hydraulic Separators
  - 2. Amtrol.
  - 3. Niles
- B. Construction: Welded steel, tested and stamped in accordance with ASME Section VIII; supplied with National Board Form U-1, rated for working pressure of 125 psig, steel support stand for floor mounting, lifting lugs..
- C. Connections: Carbon steel as listed below:
  - 1. (4) 3" flanged connections.
  - 2. 1" vent threaded.
  - 3. 1" drain.
  - 4. 3/4" threaded for sensor.
  - 5. 3/4" threaded spare.

## 2.10 AIR SEPARATORS

- A. Manufacturers:
  - 1. B+G Model Rolairtrol
  - 2. Taco.
  - 3. Spirotherm.
- B. Cast iron for sizes 2-1/2 inch and smaller, steel for sizes 3 inch and larger; perforated stainless steel air collection tube, tested and stamped in accordance with ASME SEC 8-D for 125 psig operating pressure. Pressure drop shall be less the 1.0 psig and air removal shall be minimum 91% for flows shown on the drawings. Equipment size shall match the pipe size as shown on the drawings.

2.11 PUMP SUCTION FITTINGS

- A. Manufacturers:
  - 1. B+G
  - 2. Taco
  - 3. Armstrong
  
- B. Fitting: Angle pattern, cast-iron body. Threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger. Rated for 175 psig working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings and disposable fine mesh strainer to fit over cylinder strainer.
  
- C. Accessories: Adjustable foot support, blow-down tapping in bottom, gage tapping in side.

2.12 MANUAL BALANCE VALVES

- A. Manufacturers:
  - 1. Armstrong CBV or approved equal by:
  - 2. Taco
  - 3. Macon
  
- B. Construction:
  - 1. Ametal® brass copper alloy (1/2"-2") or ASTM A536 ductile iron (2-1/2"-12") body, Y-pattern globe style, temperature and pressure test plug on inlet and outlet with check valves and screw on caps.
  - 2. Minimum of 4-360 degree handwheel turns for precise flow measurement, precise flow balancing, and shutoff eliminating the need for an additional isolation valve. EPDM O-ring seals, hidden memory feature with tamper-proof setting and digital readout. For insulation against heat loss or condensation, provide preformed rigid polyurethane insulation for sizes 1/2" through 6".

2.13 "AUTOFLOW" / AUTOMATIC BALANCING VALVES

- A. Manufacturers:
  - 1. Flow Design Inc/Autoflow
  - 2. Nexus.
  - 3. Griswold Controls
  - 4. Macon
  - 5. Nutech.
  
- B. General:
  - 1. Automatic flow control valve cartridges shall be fabricated of type 304 stainless steel and shall be factory calibrated to automatically control flow rates with ±5% accuracy over the control range of the valve.
  - 2. The automatic flow control valve shall be permanently marked to show direction of flow; and shall be provided with a valve tag to indicate flow rate, model number and equipment served.
  - 3. All automatic flow control valve cartridges shall be warranted by the manufacturer for a minimum period of five years.

- C. Construction
1. Valves 2" and smaller shall consist of brass, Y-pattern body with integral ball valve, a flow control cartridge assembly, dual pressure/temperature test ports, and interchangeable union end with O-ring seal which will accept various end pieces. The body design shall allow inspection or removal of flow control cartridge without disturbing piping connections. Valves shall be rated for a minimum working pressure of 400 psi at 250°F.
  2. Valves 2½" and larger shall consist of ductile iron, wafer-style body designed to fit between standard 125/150 ANSI flanges. Valves shall include dual pressure/temperature test ports and single or multiple, parallel-installed flow control cartridge assemblies. Flange bolts and nuts shall be provided with each valve. Valves shall be able to incorporate drains and vents as required. Valves shall be rated for a minimum working pressure of 200 psi at 250°F.
- D. Accessories:
1. Strainers
    - a. 2" and under: Y strainer shall be made of bronze with a brass cap.
    - b. 2-1/2" and larger: Y-strainer shall be made of iron (ASTM A126-61T, Class 30) Maximum pressure rating of 300 PSI.
    - c. Strainer screen shall be stainless steel and rated for 20 mesh, easily accessible for cleaning.
    - d. Strainer shall be provided with a hose end blowdown valve with cap and chain
  2. Automatic Air Vents
    - a. Forged brass body; manual shut-off cap; polypropylene float; body designed to be disassembled for cleaning, and vent capacity of one SCFM @ 60 psig.
    - b. Minimum Ratings: 150 psi at 240°F.
  3. Manual Air Vents
    - a. Brass body, knurled slotted handle, blowout-proof needle style valve, side vent, 1/4" NPT standard with extended length available.
    - b. Minimum Ratings: 400 PSIG at 250°F.
- E. Balancing valve selection shall be determined by the flow rate and velocity limit of the flow cartridge (per ASHRAE standards). Contractor shall provide a complete project valve list including item number, quantity, vendor model number, size, design flow rate, psid range and location tag to the engineer and the balancing contractor. The balancing contractor shall complete this list by adding field-verified psid for each terminal unit and submit to the engineer for record purposes.

## PART 3 EXECUTION

### 3.1 INSTALLATION - HYDRONIC PIPING SPECIALTIES

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with ASME B31.9.

- C. Provide access to devices where not exposed.
- D. Provide clearance around devices for maintenance.
- E. Use unions, flanges, and couplings downstream of devices and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- F. Locate test plugs adjacent to thermometers and thermometer sockets, at coil inlet and outlets and equipment inlet and outlets
- G. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- H. All strainer blow-down connections shall be provided with a 3/4" drain valve with hose connection and brass cap.
- I. Relief Valves:
  - 1. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
  - 2. Select system relief valve capacity greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
  - 3. Pipe relief valve outlet to nearest floor drain.
  - 4. If relief valve serves a glycol / water solution, pipe relief valve to glycol make-up tank.
  - 5. At the discharge of each relief valve, minimum pipe size shall be outlet connection size of drip pan elbow serving relief valve.
  - 6. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.
- J. Air Vents:
  - 1. Provide manual air vents at all system high points.
  - 2. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
  - 3. Where large air quantities accumulate, provide enlarged air collection standpipes.
- K. Pumps:
  - 1. Provide pump suction fitting on suction side of base mounted centrifugal pumps. Remove temporary strainers after cleaning systems.
  - 2. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps.
  - 3. Support pump fittings with floor mounted pipe and flange supports.

3.2 INSTALLATION - THERMOMETERS AND GAGES

- A. Install minimum one pressure gage for each pump, locate taps before strainers and on suction and discharge of pump; pipe to gage.
- B. Install gage taps in piping
- C. Install pressure gages with pulsation dampers. Provide needle valve to isolate each gage. Extend nipples to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches for installation of thermometer sockets. Allow clearance from insulation.
- E. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- F. Coil and conceal excess capillary on remote element instruments.
- G. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- H. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- I. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.3 FIELD QUALITY CONTROL

- A. Section 01 40 00 - Quality Requirements and 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.4 PROTECTION OF INSTALLED CONSTRUCTION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting installed construction.
- B. Do not install hydronic pressure gauges until after systems are pressure tested.

END OF SECTION 232116

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SECTION 232123 HYDRONIC PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. In-line pumps.
  - 2. Condensate pumps.
  
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
  - 3. Section 23 05 23 - General-Duty Valves for HVAC Piping: Product requirements for valves used in hydronic piping systems.
  - 4. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment: Product requirements for vibrations isolators installed with pumps.
  - 5. Section 23 21 13 - Hydronic Piping: Execution requirements for connection to pumps specified by this section.
  - 6. Section 23 21 16 - Hydronic Piping Specialties: Product and execution requirements for piping specialties installed in hydronic systems adjacent to pumps.
  - 7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to pumps specified by this section.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  
- B. Underwriters Laboratories Inc.:
  - 1. UL 778 - Motor Operated Water Pumps.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide pumps to operate at system fluid temperatures as indicated on Drawings without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Product Data: Submit certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements. Submit also, manufacturer model number, dimensions, service sizes, and finishes.

- C. Manufacturer's Installation Instructions: Submit application, selection, and hookup configuration with pipe and accessory elevations. Submit hanging and support requirements and recommendations.
  - D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.5 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Operation and Maintenance Data: Submit installation instructions, servicing requirements, assembly views, lubrication instructions, and replacement parts list.
  - C. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience and with service facilities within 100 miles of Project.
  - B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.8 DELIVERY, STORAGE, AND HANDLING
- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
  - B. Protect systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.
- 1.9 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.
- 1.10 WARRANTY
- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.



## PART 2 PRODUCTS

### 2.1 IN-LINE PUMPS

- A. Manufacturers:
  - 1. Taco.
  - 2. B+G .
  - 3. Armstrong.
  - 4. Grundfos.
- B. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 175 psig maximum working pressure. Pumps shall be in-line type for installation in vertical or horizontal piping. Pump must be capable of being serviced without disturbing pipe connections.
- C. Casing: Cast iron, with flanged pump connections, gauge ports at nozzles, vent port and drain port.
- D. Impeller: Non-ferrous material, enclosed type, dynamically balanced, keyed to the shaft and secured by a locking cap screw or nut.
- E. Seal: Liquid cavity shall be sealed off at the motor shaft by an internally-flushed mechanical seal with ceramic seal seat, and seal ring, suitable for continuous operation at 225 deg. F. A non-ferrous shaft sleeve shall completely cover the wetted area under the seal.
- F. Pump bearing bracket shall have oil lubricated bronze journal and thrust bearings. Bracket shaft shall be alloy steel having ground and hardened thrust bearing faces. A flexible coupling to dampen starting torque and torsional vibrations shall be employed.
- G. Shaft: Alloy or stainless steel with copper or bronze sleeve, integral thrust collar.
- H. Drive: Flexible coupling.
  - 1. Motors: In accordance with Section 21 05 13; 1750 rpm unless specified otherwise.
  - 2. Wiring Terminations: Furnish terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclose terminal lugs in terminal box sized to NFPA 70.
  - 3. All pumps served by a VFD shall be provided with a shaft grounding ring.
- I. Each pump shall be factory tested. It shall then be thoroughly cleaned and painted with at least one coat of high-grade machinery enamel prior to shipment. The paint shall be free of ozone depleting substances

## 2.2 CONDENSATE PUMPS

- A. Little Giant Model VCAM-20.
  - 1. Other acceptable manufacturers offering equivalent products:
    - a. Dayton.
    - b. Aspen Pumps.
- B. Pumps shall be UL listed, vertical type pump unit with ½ gallon ABS tank, stainless steel motor shaft, optional safety switch, thermal overload protection and glass filled polypropylene volute and impeller.
- C. Capacity shall be 20 gallons per hour at 16 ft hd. Pump shall be rated for intermittent liquid temperature up to 120 F.
- D. Pumps shall be 120, volt, single phase, 1/30 HP with minimum 6 foot long plug in power cord

## 2.3 ACCESSORIES

- A. Each pump served by a VFD shall be provided with an individual AEGIS grounding ring on the pump's shaft.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Coordinate that electric power is available and of the correct characteristics.
- B. Coordinate completion of bases and rails and layouts of concrete pads.
- C. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.

### 3.2 INSTALLATION

- A. Provide pumps to operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Install long radius reducing elbows or reducers between pump and piping. Support piping adjacent to pump so no weight is carried on pump casings. For close coupled or base mounted pumps, install supports under elbows on pump suction and discharge lines.
- C. Install pumps on vibration isolators. Refer to Section 23 05 48.
- D. Install floor mounted pumps on concrete housekeeping base, with anchor bolts, set and level, and grout in place. Refer to Section 23 05 48 and Division 3.

- E. Install flexible connectors at pump connections. Refer to Section 23 05 48 and 23 21 16.
  - F. Provide line sized shut-off valve and strainer (or pump suction fitting with strainer), and line sized soft seat check valve, balancing valve, and shut-off valve (or combination pump discharge valve on pump discharge). Refer to Section 23 05 23 and Section 23 21 16.
  - G. Provide air cock and drain connection on horizontal pump casings.
  - H. Provide pressure gauges with shut-off valves at inlet and outlet of each pump.
  - I. Provide drains for bases and seals; piped to and discharging into floor drains.
  - J. Lubricate pumps before start-up.
- 3.3 MANUFACTURER'S FIELD SERVICES
- A. Division 1 - Quality Requirements: Requirements for manufacturer's field services.
  - B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.
- 3.4 FIELD QUALITY CONTROL
- A. Section 01 40 00 - Quality Requirements 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.
  - B. Check, align, and certify alignment of base mounted pumps prior to start-up.

END OF SECTION 232123

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## SECTION 232500 HVAC WATER TREATMENT

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. System cleaner.
  - 2. Closed system treatment (water).
  - 3. Glycol makeup systems.
  - 4. Propylene glycol.
  - 5. Test equipment.
  
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades.
  - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
  - 3. Section 23 21 13 – Hydronic Piping.
  - 4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections specified by this section.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).

#### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate system schematic, equipment locations, and controls schematics, electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Submit placement of equipment in systems, piping configuration, and connection requirements.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- E. Manufacturers Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout products.
- B. Project Record Documents: Record actual locations of equipment and piping, including sampling points and location of chemical treatment system connections.

- C. Operation and Maintenance Data: Submit data on equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

#### 1.5 QUALITY ASSURANCE

- A. Perform Work in accordance with State and local standards for addition of non-potable chemicals to building systems and for discharge to public sewers.
- B. Maintain one copy of each document on site.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum five years documented experience as approved by manufacturer. Company shall have local representatives, water analysis laboratories and full time service personnel within 150 miles of Project.

#### 1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

#### 1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

### PART 2 - PRODUCTS

#### 2.1 WATER TREATMENT COMPANIES

- A. Water Treatment shall be provided by Jamestown Chemical Water Co, West Haven, CT
- B. Other acceptable water treatment companies include:
  - 1. Water Specialties LLC, West Suffield, CT
  - 2. Clearwater Industries, Shelton, CT

#### 2.2 SYSTEM CLEANER

- A. System Cleaner shall be Nalco 2567 with antifoam Nalco 2508 Plus or approved equal.
- B. Product Description: Liquid alkaline compound with emulsifying agents and detergents to clean piping systems including removal of grease and petroleum products

2.3 CLOSED SYSTEM WATER TREATMENT

- A. Coupon racks shall have a minimum of 2 sampling ports and shall include a flow indicator (no dole valves) and an isolation valve on both ends of the rack.
- B. Closed System Water Treatment shall include the following features:
  - 1. Sequestering agent to reduce deposits and adjust pH polyphosphate.
  - 2. Corrosion inhibitors.
  - 3. Conductivity enhancers.
- C. Propylene Glycol:
  - 1. Dow Frost HD or approved equal.

2.4 TESTING EQUIPMENT

- A. Furnish basic water test equipment, including carrying case and spare reagents for maintaining control of the program standards. Provide reagents and apparatus for determination of corrosion inhibitor and oxidizing biocide levels in the re-circulating water systems.
- B. Provide reagents and apparatus for determination of TDS (umhos) in the system. The TDS meter should be a hand held with 4 selectable ranges (0-10, 0-100, 0-1000, and 0-10,000 umhos).
- C. Provide bacteria slides for measuring total bacteria counts in the system.

2.5 SHOT FEEDERS

- A. Provide individual shot feeders where shown on the drawings. Feeder shall be 12 gallon capacity, 150 psig working pressure, with tank, funnel, vent and drain valves: Mogul or approved equivalent.
- B. Install shot feeders adjacent to respective system circulating pumps. Connect shot feeder to one pump only, according to manufacturer's instructions.
- C. Provide tank supports, inlet valves, outlet valves, pipe and fittings.

2.6 AUTOMATIC MAKEUP / GLYCOL MAKEUP SYSTEMS

- A. Wessels Model GMP. Other acceptable manufacturers offering equivalent products:
  - 1. Bell and Gossett.
  - 2. Armstrong.
  - 3. John Wood.
  - 4. Skidmore.

- B. The pumping assembly shall be mounted in a sturdy steel frame with legs to keep it off the floor. It shall include an integral pump, motor, magnetic starter, a pressure tank with a pressure control, a priming valve, a PRV, shut-off valves, strainer and a pressure gauge.
- C. It shall feature a cut-off and alarm arrangement which will stop the pump in case of excessive pressure, or a low solution level, and activate an audible (which can be silenced) and a visual alarm. A 110 V signal shall also be available for a remote alarm.
- D. A translucent polyethylene solution container, complete with a lid, shall be mounted on the pumping assembly and shall include a strainer and a shut off valve.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Systems shall be operational, pressure tested, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.

#### 3.2 MANUFACTURER'S INSTRUCTIONS

- A. Install equipment in accordance with manufacturer's instructions.
- B. Handle and introduce chemicals in accordance with manufacturer's instructions.

#### 3.3 PROCEDURES

- A. Contractor shall flush all systems with clean water including mud from drop legs. Remove, clean and replace all strainer screens.
- B. Enough cleaner shall be provided to clean all internal heat transfer surfaces, as a minimum a 2 % solution of total system volume for maximum effectiveness.
- C. Add recommended quantity of chemical directly into systems before the recirculating pumps to ensure rapid mixing and distribution throughout the system. . A small amount of antifoam (Nalco 2508 Plus or approved equal) may be added to prevent excessive foaming.
- D. Circulate the system for 48 - 72 hours. Open and drain mud legs and low points periodically during the cleaning process
- E. Drain system completely paying particular attention to mud from drop legs and all low points.
- F. Refill the system with clean, potable water; check all strainers, re-circulate and drain completely.



- G. Introduce chemicals per manufacturer's recommendations.
  - H. Test and start-up all equipment
  - I. Hot Water Heating Systems:
    - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
    - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
    - 3. Circulate for 6 hours at design temperatures, then drain.
    - 4. Refill with clean water and repeat until system cleaner is removed.
    - 5. Drain and fill with PPG / water solution.
  - J. Chilled Water Systems:
    - 1. Circulate for 48 hours, then drain systems as quickly as possible.
    - 2. Refill with clean water, circulate for 24 hours, then drain.
    - 3. Refill with clean water and repeat until system cleaner is removed.
    - 4. Drain and fill with PPG / water solution..
  - K. Geo thermal Systems:
    - 1. Circulate for 48 hours, then drain systems as quickly as possible.
    - 2. Refill with clean water, circulate for 24 hours, then drain.
    - 3. Refill with clean water and repeat until system cleaner is removed.
    - 4. Drain and fill with PPG / water solution.
- 3.4 DEMONSTRATION
- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
  - B. Furnish two hour training course for operating personnel, instruction to include installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start up of systems.

END OF SECTION 232500

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SECTION 233100 HVAC DUCTS AND CASINGS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Duct materials.
  2. Duct fabrication.
  3. Duct cleaning
  4. Ductwork leakage testing.
- B. Related Sections:
1. Section 23 04 00 – General Conditions for Mechanical Trades
  2. Section 23 07 00 – HVAC Insulation
  3. Section 23 05 93- Testing, Adjusting, and Balancing for HVAC.
  4. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.

1.2 REFERENCES

- A. ASTM International:
1. ASTM A36/A36M - Standard Specification for Carbon Structural Steel.
  2. ASTM A90/A90M - Standard Test Method for Weight Mass of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings.
  3. ASTM A240/A240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
  4. ASTM A568/A568M - Standard Specification for Steel, Sheet, Carbon, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
  5. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
  6. ASTM A1008/A1008M - Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
  7. A1011/A1011M-07 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength
  8. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
  9. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

- B. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.
  - 2. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
  - 3. NFPA 90B - Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
  
- C. Sheet Metal and Air Conditioning Contractors:
  - 1. SMACNA - HVAC Air Duct Leakage Test Manual.
  - 2. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
  - 3. SMACNA - Rectangular or Round Industrial Duct Construction Standards.
  - 4. SMACNA - Thermoplastic Duct (PVC) Construction Manual.
  
- D. Underwriters Laboratories Inc.:
  - 1. UL 181 - Factory-Made Air Ducts and Connectors.

### 1.3 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Shop Drawings: Submit Ductwork Fabrication Drawings, drawn to scale not smaller than 1/4 inch equals 1 foot, on drawing sheets same size as Contract Documents. Shop Drawings shall be submitted as colored hard copies and ACAD files and shall indicate:
  - 1. Fabrication, assembly, and installation details, including plans, elevations, sections, details of components, and attachments to other work.
  - 2. Duct layout, indicating sizes, pressure classifications and duct gages and in plan view. For exhaust duct systems, indicate classification of materials handled as defined in this section.
  - 3. Fittings.
  - 4. Reinforcing details and spacing.
  - 5. Seam and joint construction details.
  - 6. Penetrations through fire rated and other walls.
  - 7. Terminal unit, coil, and humidifier installations.
  - 8. Hangers and supports, including methods for building attachment, vibration isolation, and duct attachment.
  
- C. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.5 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used. Record Documents shall be submitted as hard copies and ACAD files.

1.6 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
- B. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards as applicable.
- C. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum four week2 prior to commencing work of this section.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- C. Maintain temperatures during and after installation of duct sealant.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 1.
- B. Delivery:
  - 1. Open ends of ductwork shall be sealed during delivery and storage.
  - 2. At the time of delivery all materials shall be visually inspected for damage. Any damaged products, boxes, crates, , etc. shall be noted on the receiving ticket and immediately reported to the shipping company and the material manufacturer.

- C. Storage:
  - 1. Material may be stored either indoors or outdoors.
  - 2. If stored outdoors the material must be raised sufficiently off the ground to prevent it from being flooded.
  - 3. If stored outdoors the material must be covered with a weather proof flame resistant sheeting or tarpaulin.

#### 1.11 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.12 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

### PART 2 PRODUCTS

#### 2.1 DUCT MATERIALS

- A. Galvanized Steel Ducts: ASTM A653/A653M galvanized steel sheet, lock-forming quality, having G60 zinc coating of in conformance with ASTM A90/A90M; minimum 26 gage.
- B. Steel Ducts: ASTM A568/A568M. All connections shall be welded or flanged type.
- C. Fasteners: Rivets, bolts, or sheet metal screws.
- D. Hanger Rod: ASTM A36/A36M; steel; threaded both ends, threaded one end, or continuously threaded.
- E. Stainless Steel Ducts: ASTM A240/A240M or ASTM A666, Type 304.
- F. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength. Support with aluminum threaded rod.

#### 2.2 METAL DUCTWORK FABRICATION

- A. Fabricate and support rectangular ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- B. Fabricate and support round ducts with longitudinal seams in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible (Round Duct Construction Standards). Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.

- C. Construct T's, bends, and elbows with minimum radius 1-1/2 times centerline duct width. Where not possible and where rectangular elbows are used, provide airfoil turning vanes. Where acoustical lining is indicated, furnish turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings two gages heavier than duct gages indicated in SMACNA Standard. Minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- F. Provide standard 45-degree lateral wye takeoffs. When space does not allow 45-degree lateral wye takeoff, use 90-degree conical tee connections.
- G. Seal joints between duct sections and duct seams with welds, gaskets, mastic adhesives, mastic plus embedded fabric systems, or tape.
  - 1. Sealants, Mastics and Tapes: Conform to UL 181A. Provide products bearing appropriate UL 181A markings.
  - 2. Sealants shall be low VOC, water resistant, fire resistive.

### 2.3 FLEXIBLE DUCTS

- A. Manufacturers:
  - 1. Thermaflex
  - 2. Technaflex
  - 3. Tuttle + Bailey
- B. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical-wound spring steel wire.
  - 1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
  - 2. Maximum Velocity: 4000 fpm.
  - 3. Temperature Range: -20 degrees F to 210 degrees F.

### 2.4 INSULATED FLEXIBLE DUCTS

- A. Manufacturers:
  - 1. Thermaflex M-KE or approved equal by:
  - 2. Technaflex
  - 3. Tuttle + Bailey
- B. Product Description: UL 181, Class 1, aluminum laminate and polyester film with latex adhesive supported by helical wound spring steel wire; fiberglass insulation; and outer jacket of fiberglass reinforced metalized film barrier.
  - 1. Pressure Rating: 10 inches wg positive and 1.0 inches wg negative.
  - 2. Maximum Velocity: 5000 fpm.
  - 3. Temperature Range: -20 degrees F to 210 degrees F.
  - 4. Thermal Resistance: 4.2 square feet-hour-degree F per BTU.

2.5 SINGLE WALL SPIRAL ROUND AND FLAT OVAL DUCTS

- A. Manufacturers:
  - 1. McGill AirFlow Corporation
  - 2. Semco Incorporated
  - 3. Spiral Mfg. Co., Inc
  - 4. Eastern Sheet Metal.
- B. Product Description: Machine made, UL 181, Class 1, round spiral lockseam duct constructed of ASTM A527 galvanized steel with G60 zinc coating in conformance with ASTM A90; rated for 10 inches wg pressure or ASTM B209; aluminum sheet, alloy 3003-H14 per schedules below.

2.6 DOUBLE WALL DUCTWORK

- A. Manufacturers:
  - 1. McGill AirFlow Corporation
  - 2. Semco Incorporated
  - 3. Spiral Mfg. Co., Inc.
  - 4. Eastern Sheet Metal.
- B. Double Wall Round and Oval Product Description: McGill AirFlow Acouti-k27 or approved equal, machine made, UL 181 round spiral lockseam or solid weld duct with light reinforcing corrugations, minimum 28 gauge galvanized steel outer wall, 1 inch thick glass fiber insulation, minimum 24 gauge perforated galvanized steel inner wall; fittings of the same constructions. Rating shall be for 10 inches wg. Galvanized steel shall be ASTM A527 steel with G60 zinc coating in conformance with ASTM A90.
- C. Ductwork to be painted in the field. Provide prep on exterior for field painting.

2.7 CASINGS / PLENUMS

- A. Fabricate casings and plenums in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible and construct for operating pressures indicated.
- B. Reinforce access door frames with steel angles tied to horizontal and vertical plenum supporting angles. Furnish hinged access doors where indicated or required for access to equipment for cleaning and inspection.
- C. At all access doors, furnish clear wire glass observation ports, minimum 6 x 6 inch size.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify sizes of equipment connections before fabricating transitions.



3.2 INSTALLATION

- A. Install, support and seal ducts in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- B. During construction, install temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Duct sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- D. Use crimp joints with or without bead or beaded sleeve couplings for joining round duct sizes 8 inch and smaller.
- E. Use double nuts and lock washers on threaded rod supports.
- F. Set plenum doors 6 to 12 inches above floor. Arrange door swing so fan static pressure holds door in closed position.
- G. Plenums and Casings: Install floor mounted casings on 4 inch high concrete curbs. Refer to Section 03 30 00. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, furnish liner of 18 gage galvanized expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- H. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- I. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct usable space or block access for servicing building and its equipment
- J. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.
- K. Provide openings in ductwork where required to accommodate control devices. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring
- L. Provide duct access doors for inspection and cleaning before and/or after filters, coils, manual dampers, control dampers, control devices, fire dampers, combination fire and smoke dampers, and where shown on the drawings. Minimum door size shall be 10 x 12 inches except where limited by duct size. Minimum door size at intake or exhaust plenums shall be 18 x 24.

- M. Flexible Ductwork and Insulated Flexible Ductwork:
  - 1. Ductwork systems which cross rated walls of 1 hour or less shall be continuous, minimum 26 gauge ductwork systems. Flexible duct shall not be installed.
  - 2. Connect terminal units such as VAV boxes to supply ducts with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
  - 3. Connect diffusers to low pressure ducts with 8 feet maximum length of flexible duct held in place with strap or clamp
  - 4. Connect flexible ducts to metal ducts with adhesive plus sheet metal screws.
  
- N. Louvers and Roof Hoods: All unused sections shall be sealed off / “blanked-off” with double wall insulated panels. Panels shall encase 2” rigid insulation, Type D-2 per Specification Section 23 0700.
  
- O. Ductwork (non-insulated) installed at the exterior of the building shall be aluminum construction. Joins shall be made with flanged duct connections designed for weatherproof installation. Provide with gaskets for installation outside the building (temperature ranges and weather resistant).
  
- P. Exhaust Outlet Locations:
  - 1. Minimum Distance from Property Lines: 3 feet.
  - 2. Minimum Distance from Building Openings: 3 feet.
  - 3. Minimum Distance from Outside Air Intakes: 25 feet.

### 3.3 DUCTWORK LEAKAGE TESTING

- A. The following ductwork systems shall be pressure/leakage tested:
  - 1. All ductwork to be concealed in a sheetrock, concrete block or other permanent chase shall be pressure tested before ductwork is concealed.
  - 2. All supply air and return ductwork installed in Lower Level Mech Room and Mezzanine Mech Room.
  - 3. Exhaust ductwork serving hood in laboratory.
  
- B. Testing shall conform to the following:
  - 1. Test in accordance with SMACNA HVAC Air Duct Leakage Test Manual. Maximum Allowable Leakage shall be in accordance with Duct Pressure Class rating listed below and Leakage Class listed here-in.
  - 2. For Ductwork Pressure Class 3” w.c: Leakage Class shall be 8.
  - 3. For Ductwork Pressure Class 2” w.c: Leakage Class shall be 16.
  - 4. Testing shall occur after ductwork has been cleaned, but before duct insulation is applied or ductwork is concealed.
  - 5. During the ductwork leakage test, the pressure maintained in the ductwork shall be set for the Ductwork Pressure Class.
  
- C. Duct Leakage Test Report shall include:
  - 1. Date of test.
  - 2. Name of company and person conducting the test.
  - 3. Name of company and person witnessing the test.

4. Description of ductwork tested. Provide drawings to indicate section of ductwork being tested. Labeling on the drawings shall correspond to labeling in the report.
5. Surface area (square feet) of section of ductwork being tested.
6. Duct design operating pressure (inches w.c.)
7. Duct design test static pressure (inches w.c.)
8. Duct capacity, air flow
9. Specified Leakage Class.
10. Leakage factor (CFM / 100 sf of duct area)
11. Maximum allowable leakage (CFM)
12. Test apparatus
  - a. Blower
  - b. Orifice tube size
  - c. Orifice size
  - d. Calibrated
13. Test orifice differential pressure (inches w.c.)

#### 3.4 DUCTWORK CLEANING

- A. All interior surfaces of new ductwork and new air handling equipment shall be vacuum cleaned.
- B. Provide duct access doors of adequate size and quantities to allow thorough cleaning and inspection. .

#### 3.5 SCHEDULES

- A. Ductwork Material Schedule:

AIR SYSTEM	MATERIAL
Supply Air and Return Air unless noted otherwise	Galvanized Steel
Relief Air unless noted otherwise	Galvanized Steel
Outside Air unless noted otherwise	Galvanized Steel
Outside Air Plenums	Aluminum
Combustion Air Intake	Galvanized Steel
General Exhaust unless noted otherwise	Galvanized Steel
Exhaust Branch Serving Locker Rooms (Branch Ductwork to mains including volume dampers)	Aluminum

Supply Air and Return Serving Open Areas (areas without hung ceilings) Including Open Office, Break Room, Reception Area, Lobby, Conference Room, Training Room, Kitchen, etc.	Double Wall Round and Double Wall Flat Oval
Fume Hood Exhaust	Aluminum

B. Ductwork Pressure Class Schedule:

AIR SYSTEM	PRESSURE CLASS
Supply Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Return Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Outside Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Exhaust Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Relief Air Unless Noted Otherwise	2 inch w.c. regardless of velocity.
Fume Hood Exhaust	2 inch w.c.

END OF SECTION 233100

SECTION 233300 AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Duct access doors.
  - 2. Dynamic fire dampers.
  - 3. Volume control dampers/balancing dampers.
  - 4. Remotely controlled volume dampers.
  - 5. Flexible duct connections.
  - 6. Duct test holes.
  
- B. Related Sections:
  - 1. Section 23 09 23 - Direct-Digital Control System for HVAC: Execution and Product requirements for connection and control of Combination Smoke and Fire Dampers for placement by this section.
  - 2. Section 23 31 00 - HVAC Ducts and Casings: Requirements for duct construction and pressure classifications.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc.:
  - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
  
- B. ASTM International:
  - 1. ASTM E1 - Standard Specification for ASTM Thermometers.
  
- C. National Fire Protection Association:
  - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
  - 2. NFPA 92A - Recommended Practice for Smoke-Control Systems.
  
- D. Sheet Metal and Air Conditioning Contractors:
  - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
  
- E. Underwriters Laboratories Inc.:
  - 1. UL 555 - Standard for Safety for Fire Dampers.
  - 2. UL 555C - Standard for Safety for Ceiling Dampers.
  - 3. UL 555S - Standard for Safety for Smoke Dampers.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors, and duct test holes.

- C. Product Data: Submit data for shop fabricated assemblies and hardware used.
  - D. Materials of construction shall match ductwork materials. Refer to Section 23 3100.
  - E. Product Data: Submit for the following. Include where applicable electrical characteristics and connection requirements.
    - 1. Fire dampers including locations and ratings.
    - 2. Backdraft dampers.
    - 3. Flexible duct connections.
    - 4. Volume control dampers.
    - 5. Duct access doors.
    - 6. Duct test holes.
  - F. Product Data: For fire dampers submit the following:
    - 1. Include UL ratings, dynamic ratings, leakage, pressure drop and maximum pressure data.
    - 2. Indicate materials, construction, dimensions, and installation details.
    - 3. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
  - G. Manufacturer's Installation Instructions: Submit for Fire and Combination Smoke and Fire Dampers.
  - H. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.4 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Project Record Documents: Record actual locations of access doors.
- 1.5 QUALITY ASSURANCE
- A. Dampers tested, rated and labeled in accordance with the latest UL requirements.
  - B. Damper pressure drop ratings based on tests and procedures performed in accordance with AMCA 500.
  - C. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect dampers from damage to operating linkages and blades.
- C. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly indicating manufacturer and material.
- D. Storage: Store materials in a dry area indoor, protected from damage.
- E. Handling: Handle and lift dampers in accordance with manufacturer's instructions. Protect materials and finishes during handling and installation to prevent damage.

1.9 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

1.10 COORDINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Coordinate Work where appropriate with building control Work.

1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 DUCT ACCESS DOORS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated on Drawings.
- B. Fabrication: Rigid and close fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ductwork, furnish minimum 1 inch thick insulation with double wall, sheet metal cover.
  - 1. Less than 12 inches square, secure with sash locks.
  - 2. Up to 18 inches Square: Furnish two hinges and two sash locks.
  - 3. Up to 24 x 48 inches: Three hinges and two compression latches with outside and inside handles.
  - 4. Access doors with sheet metal screw fasteners are not acceptable.

## 2.2 DYNAMIC FIRE DAMPERS

- A. Manufacturers:
  - 1. Ruskin models noted below.
  - 2. Other acceptable manufacturers offering equivalent products include:
    - a. Air Balance.
    - b. Greenheck.
    - c. Prefco.
- B. Fabricate in accordance with NFPA 90A and UL 555, and as indicated.
- C. Ceiling Dampers: Galvanized steel, minimum 22 gage frame and 22 gage insulated blades. Provide with adjustable air flow balancing device and thermal insulation blanket for diffusers. Dampers shall be Ruskin Model CFD.
- D. Curtain Type Dampers: Galvanized steel minimum 22 gage frame and interlocking blades normally set out of the air stream. Provide stainless steel closure springs and latches. Damper shall be Ruskin Model DIBD.
- E. Multiple Blade Dampers: 16 gage galvanized steel frame and blades, oil-impregnated bronze or stainless steel sleeve bearings and plated steel axles, 1/8 x 1/2 inch plated steel concealed linkage, stainless steel closure spring, blade stops, and lock. Damper shall be Ruskin Model FD35.
- F. As required by ductwork fabrication shop drawings, Damper "Out-of-Wall" applications shall be Model FD/OW or approved equal and shall be provided with factory insulation between damper and wall.
- G. Fusible Links: UL 33, separate at 165 degrees F.
- H. Fire rating of dampers shall be 1 1/2 hour unless noted otherwise on the drawings.
- I. Fire dampers shall be labeled according to UL 555 Type "B", dynamically rated to close under maximum flow conditions. Static rated dampers are unacceptable.

## 2.3 VOLUME CONTROL DAMPERS / BALANCING DAMPERS

- A. Manufacturers:
  - 1. Ruskin models noted below.
  - 2. Other acceptable manufacturers offering equivalent products include:
    - a. Air Balance.
    - b. Greenheck.
- B. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.



- C. Single Blade Dampers: For duct sizes up to 12 x 36 inch and 20 inch diameter with minimum 20 gage frame and blade and molded synthetic bearings. Damper shall be Ruskin Model MD25 and MDRS 25.
- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 x 48 inch. Provide with minimum 16 gage frame and blades and molded synthetic bearings. Dampers shall be Ruskin Model MD35.
- E. Quadrants:
  - 1. Provide locking, indicating quadrant regulators on single and multi-blade dampers.
  - 2. On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
  - 3. Where rod lengths exceed 30 inches provide regulator at both ends.
- F. Damper Marker Tape: Attach bright colored tape to each damper for ease of identifying dampers in the field. Tape shall hang down below bottom of duct the damper is serving.

#### 2.4 REMOTELY OPERATED VOLUME DAMPERS

- A. Manufacturers
  - 1. Metro Air Tech
  - 2. Young Regulators
- B. Produce Description
  - 1. Furnish cable operated remote controlled volume dampers in branch ducts located at inaccessible ceilings and where indicated on the Drawings. Reference architectural drawings for locations of gypsum board and spline etc. ceilings.
  - 2. Dampers are adjustable with standard tools at the ceiling line by one of the following methods:
    - a. Through face of the diffuser or grille.
    - b. Round or rectangular steel cup secured to accessible ceiling framing or accessible wall mounted locations approved by Architect and Owner.
  - 3. Powder painted steel box cover plate shall be fastened with standard countersunk (Option: tamperproof countersunk) screws providing a secure, unobtrusive appearance flush with the ceiling surface.
  - 4. Galvanized steel, square-shafted damper shall be worm gear actuated via a brass plated rotary cable meeting Mil-spec I-45208 and supported at the damper end by a self lubricating bearing integral to the worm gear assembly.
  - 5. Additional cable retainer supports shall be factory furnished as required by the cable length. Rotary cable shall have a minimum torque service factor of 200% when installed in accordance with manufacturer furnished instructions. Ceiling Cup, rotary cable, and worm gear shall be furnished as one piece for installation with no linkage adjustment required or small parts to get lost on site. Positive, direct, two-way damper control shall be provided with no sleeves, springs, or screw adjustments to come loose after ceiling closure.

## 2.5 FLEXIBLE DUCT CONNECTIONS

- A. Fabricate in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible, and as indicated.
- B. Connector: Fabric crimped into metal edging strip.
  - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.
  - 2. Net Fabric Width: Approximately 3 inches wide.
  - 3. Metal: 3 inch wide, 24 gage galvanized steel.

## 2.6 DUCT TEST HOLES

- A. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Furnish extended neck fittings to clear insulation.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify rated walls are ready for fire damper installation.
- C. Verify ducts and equipment installation are ready for accessories.
- D. Check location of air outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

### 3.2 INSTALLATION.

- A. Install in accordance with NFPA 90A, and follow SMACNA HVAC Duct Construction Standards - Metal and Flexible. Refer to Section 23 31 00 for duct construction and pressure class.
- B. Access Doors: Install access doors at the following locations and as indicated on Drawings:
  - 1. Spaced every 50 feet of straight duct or less spacing as required for cleaning of ductwork.
  - 2. Upstream of each elbow.
  - 3. Upstream of each reheat coil.
  - 4. Before and after each duct mounted filter.
  - 5. Before and after each duct mounted coil.
  - 6. Before and after each duct mounted fan.
  - 7. Before and after each automatic control damper.
  - 8. Before and after each fire damper, smoke damper, combination fire and smoke damper.
  - 9. Downstream of each VAV box..

- C. Access Door Sizes: Install minimum 12 x 12 inch size for hand access, 18 x 18 inch size for shoulder access.
  - D. Install fire dampers at locations as indicated on Drawings at all rated walls and partitions (refer to architectural drawings and code drawings); including 1 hour rated walls and partitions. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
    - 1. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92A.
    - 2. Install dampers square and free from racking with blades running horizontally.
    - 3. Do not compress or stretch damper frame into duct or opening.
    - 4. Handle damper using sleeve or frame. Do not lift damper using blades, actuator, or jack shaft.
    - 5. Install bracing for multiple section assemblies to support assembly weight and to hold against system pressure. Install bracing as needed.
  - E. Installation of Volume Control Dampers:
    - 1. Provide at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing and where shown on drawings. Install minimum 2 duct widths from duct take-off.
    - 2. Provide volume control / balancing dampers on duct take-off to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly.
    - 3. At each damper, attach Damper Marker Tape for ease of identifying dampers in the field. Tape shall hang down below bottom of duct.
  - F. Remote controlled volume dampers shall be installed in branch ducts located at inaccessible ceilings and where indicated on the Drawings. Reference architectural drawings for locations of gypsum board and spline etc. ceilings.
  - G. Install flexible duct connections immediately adjacent to equipment in ducts associated with fans and motorized equipment.
  - H. Install temporary duct test holes and required for testing and balancing purposes. Cut or drill in ducts. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.
- 3.3 DEMONSTRATION
- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
  - B. Demonstrate re-setting of fire dampers to Owner's representative.

END OF SECTION 233300

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## SECTION 233303 SOUND ATTENUATORS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Sound Attenuators.
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment: Product requirements for hangers, supports and sleeves for placement by this section.
  - 3. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
  - 4. Section 23 31 00 – HVAC Ducts and Casings.

#### 1.2 REFERENCES

- A. ANSI S12.60 – Acoustical Performance Criteria, Design Requirements and Guidelines for Schools
- B. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- C. NFPA 90B - Installation of Warm Air Heating and Air Conditioning Systems.
- D. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

#### 1.3 PERFORMANCE REQUIREMENTS

- A. Variation of duct configuration or sizes other than those of equivalent or lower loss coefficient is not permitted except by written permission. Size round ducts installed in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

#### 1.4 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data:
  - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials.
  - 2. Select sound attenuators based on actual HVAC equipment that is being provided. Review shop drawings for Air Handling Units and Air Terminal Units and provide sound attenuator selections that match the equipment's sound data.
  - 3. Submit sound data at rated capacity.

- C. Manufacturer's Installations Instructions.
  - D. Provide acoustical system calculations for all duct systems with silencers to demonstrate the silencers shall reduce noise levels from all AHU's to NC and dBa values stated on contract documents (ANSI S12.60). Use sound power levels of actual equipment to be installed on project. Analysis shall include breakout noise calculations. In the absence of specified background sound level criteria, the guidelines as expressed in the "Sound and Vibration Control" Chapter of the ASHRAE Handbook - HVAC Applications, shall be used. Spaces shall be designed for:
    - 1. Lobby: Maximum dBa of 35.
    - 2. Training Room: Maximum dBa of 35
    - 3. Offices: Maximum NC-30.
    - 4. Conference rooms: Maximum NC-30.
  - E. The manufacturer shall supply certified test data for each scheduled silencer. The data shall include dynamic insertion loss, generated noise and pressure drop for forward or reverse flow, matching the project's air distribution system requirement. All ratings shall be conducted in the same facility and shall utilize the same silencer.
  - F. Test facilities and test reports shall be open to inspection upon request from the Engineer. Silencer performance shall be substantiated by laboratory testing according to ASTM E-477 and so certified when submitted for approval. The aero-acoustic laboratory shall be NVLAP accredited for the ASTM E-477 test standard. A copy of the accreditation certificate shall be included with the submittals.
- 1.5 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.
- 1.6 QUALITY ASSURANCE
- A. Perform Work in accordance with SMACNA - HVAC Duct Construction Standards - Metal and flexible.
  - B. Construct ductwork to NFPA 90A standards.
  - C. Maintain one copy of each document on site.
  - D. Perform Work in accordance with SMACNA publication as scheduled in Part 3 - Execution.
  - E. Silencer manufacturer shall operate its own duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with ASTM E-477. The facility shall maintain NVLAP accreditation for the E-477 test standard.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years experience.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01 60 00 - Product Requirements.
- B. Do not install duct sealant when temperatures are less than those recommended by sealant manufacturers.
- C. Maintain temperatures during and after installation of duct sealant.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Vibro-Acoustics.
- B. Other manufacturers offering similar products.
  - 1. Industrial Acoustics Company.
  - 2. McGill Airflow.
  - 3. Price.

2.2 MATERIALS

- A. Rectangular Silencers: All rectangular silencers shall be constructed with a 22 gauge galvanized steel outer casing and 26 gauge galvanized perforated steel.
- B. Elbow Silencers: All elbow silencers shall be constructed with an 18 gauge galvanized steel outer casing and 22 gauge galvanized perforated steel. All acoustical splitters shall be internally radiused and aerodynamically designed for efficient turning of the air. Half and full splitters are required as necessary to achieve the scheduled insertion loss. All elbow silencers with a turning cross-section dimension greater than 48" shall have at least two half splitters and one full splitter.

- C. Vibro-Acoustics Model RD - Fiberglass Acoustic Media: Media shall be of acoustic quality, shot-free glass fiber` insulation with long, resilient fibers bonded with a thermosetting resin. Glass fiber density and compression shall be as required to insure conformance with laboratory test data. Glass fiber shall be packed with a minimum of 15% compression during silencer assembly. Media shall be resilient such that it will not crumble or break, and conform to irregular surfaces. Media shall not cause or accelerate corrosion of aluminum or steel. Mineral wool will not be permitted as a substitute for glass fiber.
- D. Combustion Ratings: Silencer materials, including acoustic media shall have maximum combustion ratings as noted below when tested in accordance with ASTM E84, NFPA 255 or UL 723.
  - Flamespread Classification: 15
  - Smoke Development Rating: 10

### 2.3 CONSTRUCTION

- A. Silencers shall be constructed in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed. Material gauges noted in “Section B Materials”, are minimums. Material gauges shall be increased as required for the system pressure and velocity classification. The silencers shall not fail structurally when subjected to a differential air pressure of 8 inches water gauge.
- B. Casings shall be lockformed and sealed, except as noted in Section B Materials, to provide leakage-resistant construction. Airtight construction shall be achieved by use of a duct-sealing compound supplied and installed by the contractor at the jobsite.
- C. All perforated steel shall be adequately stiffened to insure flatness and form. All spot welds shall be painted.

### 2.4 ACOUSTIC PERFORMANCE

- A. Silencer dynamic insertion loss shall not be less than that listed in the schedule.
- B. Acoustic performance shall include dynamic insertion loss and generated noise for forward flow (air and noise in same direction) or reverse flow (air and noise in opposite direction) in accordance with the project’s air distribution system requirements.
- C. All silencer ratings shall be determined in a duct-to-reverberant room test facility which provides for airflow in both directions through the test silencer in accordance with the ASTM E-477 test standard. The test set-up, procedure and facility shall eliminate all effects due to flanking, directivity, end reflection, standing waves and reverberation room absorption.



2.5 AERODYNAMIC PERFORMANCE

- A. Silencer pressure drops shall not exceed those listed in the schedule. Pressure drop measurements shall be made in accordance with the ASTM E-477 test standard. Tests shall be conducted and reported on the identical units for which acoustical data is presented.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify sizes of equipment connections before fabricating transitions.

3.2 INSTALLATION

- A. Use double nuts and lock washers on threaded rod supports.
- B. Install equipment in accordance with manufacturer's instructions, NFPA 90A, and SMACNA publications and guidelines.

3.3 MATERIAL STORAGE ON-SITE

- A. All attenuators stored on-site should be elevated from the ground and sealed or covered to protect from moisture and dirt accumulation.

3.4 PROTECTION OF FINISHED WORK

- A. Immediately after installation, seal all supply, return and exhaust openings not under immediate work (open ends in ductwork runs) with plastic.

PART 4 ACOUSTIC PERFORMANCE DATA

4.1 NOTES FOR ALL PERFORMANCE DATA

- A. Model Number shall be as manufactured by Vibro-Acoustics.
- B. Length of elbow silencers shall be centerline dimensions from face of inlet to the face of the outlet.
- C. HTL = 10 gauge casing (High Transmission Loss)
- D. Type RED shall be elbow type. Type RD shall be straight type. RED and RD Series shall be provided with fiberglass acoustic media as specified above.

4.2 DYNAMIC INSERTION LOSSES – SPECIFIC SOUND ATTENUATORS

- A. Sound attenuators shall be located at the discharge and inlet to each respective AHU and shall be rated for maximum 1,250 fpm unless noted otherwise.
- B. AHU-1: SAT-AHU-1S (SA) and SAT-AHU-2R (RA) shall be rated for 2,500 cfm and 2,200 cfm respectively. Each shall be 60” long elbow type.
- C. AHU-2: SAT-AHU-2S (SA) and SAT-AHU-2R (RA) shall be rated for 800 cfm and 750 cfm respectively. Each shall be 60” long elbow type; rated for maximum 750 fpm.
- D. AHU-3: SAT-AHU-3S (SA) and SAT-AHU-3R (RA) shall be rated for 3,500 cfm and 3,200 cfm respectively. Each shall be 60” long elbow type.
- E. AHU-4: SAT-AHU-4S (SA) and SAT-AHU-4R (RA) shall be rated for 1,600 cfm and 1,500 cfm respectively. Each shall be 60” long elbow type.
- F. AHU-5: SAT-AHU-5S (SA) and SAT-AHU-5R (RA) shall be rated for 1,600 cfm and 1,500 cfm respectively. Each shall be 60” long elbow type.

END OF SECTION 233303

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**SECTION 233400 HVAC FANS****PART 1 GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. In line fans.
  - 2. Ceiling mounted fans.
  - 3. Ceiling fans.
  
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
  - 3. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment: Product requirements for resilient mountings and snubbers for fans for placement by this section.
  - 4. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
  - 5. Section 23 31 00 - HVAC Ducts and Casings: Product requirements for hangers for placement by this section.
  - 6. Section 23 33 00 - Air Duct Accessories: Product requirements for duct accessories for placement by this section.
  - 7. Section 26 05 03 - Equipment Wiring Connections: Execution and product requirements for connecting equipment specified by this section.

**1.2 REFERENCES**

- A. American Bearing Manufacturers Association:
  - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
  - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
  
- B. Air Movement and Control Association International, Inc.:
  - 1. AMCA 99 - Standards Handbook.
  - 2. AMCA 204 - Balance Quality and Vibration Levels for Fans.
  - 3. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - 4. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
  - 5. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

- C. American Refrigeration Institute:
    - 1. ARI 1060 - Air-to-Air Energy Recovery Ventilation Equipment Certification Equipment Program.
  - D. ASTM International:
    - 1. ASTM E1996 - Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
  - E. National Electrical Manufacturers Association:
    - 1. NEMA MG 1 - Motors and Generators.
    - 2. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  - F. Underwriters Laboratories Inc.:
    - 1. UL 705 - Power Ventilators.
- 1.3 PERFORMANCE REQUIREMENTS
- A. Wind-Borne Debris Loads: Design louvers located within 30 feet of grade to withstand ASTM E1996; large missile impact test.
- 1.4 SUBMITTALS
- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  - B. Shop Drawings: Indicate size and configuration of fan assembly, mountings, weights, ductwork connections and accessory connections.
  - C. Product Data: Submit data on each type of fan and include accessories, fan curves with specified operating point plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, electrical characteristics and connection requirements.
  - D. Manufacturer's Installation Instructions: Submit fan manufacturer's instructions.
  - E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.5 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Operation and Maintenance Data: Submit instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

## 1.6 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
- C. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- D. Balance Quality: Conform to AMCA 204.
- E. Maintain one copy of each document on site.

## 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

## 1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Protect motors, shafts, and bearings from weather and construction dust.

## 1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

## 1.11 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish one year manufacturer's warranty for fans.

### 1.12 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish two sets of belts for each fan.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS – IN LINE FANS AND CEILING FANS

- A. Manufacturers of HVAC fans and hoods shall be as specified in this list unless noted otherwise:
  - 1. Greenheck
  - 2. Loren Cook
  - 3. Twin City
  - 4. Acme

### 2.2 CENTRIFUGAL INLINE FANS

- A. Product Description: Direct drive with galvanized steel housing, integral inlet cone, removable access doors on 3 sides, inlet and outlet duct collar, gravity backdraft damper in discharge, horizontal hanging brackets.
- B. Fan Wheel: Backward inclined centrifugal type, aluminum construction.
- C. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
- D. Motor and Drive Mounting: Out of air stream.
- E. Motor: Open drip proof.
- F. Bearings: ABMA 9 life at 200,000 hours.
- G. Accessories:
  - 1. Fan speed controller shall be provided for all direct drive fans and where shown on the drawings.
  - 2. Belt guard.
  - 3. Motor cover.
  - 4. Inlet safety screen where intake is not ducted.
  - 5. Flexible duct connector.
  - 6. Inlet and outlet ductwork companion flange.
  - 7. Disconnect Switch: NEMA 250 Type 1 enclosure.

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### 2.3 CEILING EXHAUST FANS

- A. Product Description: Fan shall be ceiling mounted, direct driven, centrifugal exhaust fan.
- B. Construction: Fan wheel housing and integral outlet duct collar shall be injection molded from an engineered resin exceeding UL requirements for smoke and heat generation. The outlet duct shall have provision for an aluminum backdraft damper with continuous aluminum hinge rod. The inlet box shall be minimum 22 gauge galvanized steel. Motor shall be isolation mounted to a one piece galvanized stamped steel integral motor mount/inlet. A field wiring compartment with disconnecting means shall be standard. To accommodate different ceiling thickness, an adjustable pre-punched mounting bracket shall be provided.
- C. Ceiling Grilles: White, non-yellowing, high impact styrene injection molded. Unit shall be designed with provision for field conversion from ceiling to inline.
- D. Wheel: Wheel shall be centrifugal forward curved type, injection molded of polypropylene resin. Wheel shall be balanced in accordance with AMCA Standard 204-05, Balance Quality and Vibration Levels for Fans.
- E. Motor: Motor shall be permanent split capacitor with permanently lubricated sealed bearings and include impedance or thermal overload protection and disconnect plug. Motor shall be furnished at the specified voltage.
- F. Wiring to fan shall be "hard wired".
- G. Accessories:
  - 1. Fan speed controller shall be provided for all direct drive fans and where shown on the drawings.
  - 2. Backdraft damper.
  - 3. Flexible duct connector.

### 2.4 CEILING FANS

- A. Manufacturers:
  - 1. Haiku.
  - 2. Hunter.
  - 3. Modern.
- B. Product Description: Single stem, ceiling mounted fan with universal mount, white hardware finish and Caramel bamboo airfoils. Provide with three airfoils per fan with 60" fan sweep.
- C. Motors shall be high efficiency, brushless DC type with digital inverter drives. Fans shall operate from 120 volt, single phase power. Motors shall be variable speed. Amperage draw shall be 26.6 watts at maximum speed.

- D. Capacity shall be 1,450 cfm at min speed and 6,500 cfm at 200 rpm.
- E. Provide with universal mount, escutcheon at ceiling penetration, mounting hardware and remote control for each fan.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify roof curbs are installed and dimensions are as instructed by manufacturer.

#### 3.2 INSTALLATION

- A. Secure hoods with cadmium plated steel lag screws to roof curb. Secure roof fans with cadmium plated steel lag screws to roof curb. For other requirements, refer to Specification 230548.
- B. In line Fans: Install flexible connections specified in Section 23 33 00 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Install safety screen where inlet or outlet is exposed.
- D. For belt driven fans, provide sheaves required for final air balance.

#### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Division 1 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

#### 3.4 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean inside of fan cabinet.

#### 3.5 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate fan operation and maintenance procedures.



3.6 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate fans for until ductwork is clean, filters in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 233400

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## SECTION 233600 AIR TERMINAL UNITS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Constant volume terminal units.
  - 2. Variable air volume terminal units.
  
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 09 23 - Direct-Digital Control System for HVAC: Controls remote from unit.
  - 3. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
  - 4. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electrical connections to air terminal units specified by this section.

#### 1.2 REFERENCES

- A. American Refrigeration Institute:
  - 1. ARI 880 - Air Terminals.
  - 2. ARI 885 -Procedure for Estimating Occupied Space Sound Levels in the Application of Air Terminals and Air Outlets.
  
- B. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  
- C. National Fire Protection Association:
  - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
  
- D. Underwriters Laboratories Inc.:
  - 1. UL 181 - Factory-Made Air Ducts and Connectors.

#### 1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Product Data: Submit data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings indicating airflow, static pressure, and NC designation. Include electrical characteristics and connection requirements. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 inch to 4 inches wg.

- C. Manufacturer's Installation Instructions: Submit support and hanging details, and service clearances required.
  - D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.4 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Project Record Documents: Record actual locations of units.
  - C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant volume regulators.
- 1.5 QUALITY ASSURANCE
- A. Test and rate air terminal units performance for air pressure drop, flow performance, and acoustical performance in accordance with ARI 880 and ARI 885. Attach ARI seal to each terminal unit.
  - B. Maintain one copy of each document on site.
- 1.6 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
  - B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- 1.7 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.8 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.
- 1.9 COORDINATION
- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
  - B. Coordinate Work with 15905 - HVAC Instrumentation and Controls.

1.10 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish one year manufacturer warranty for air terminal units.

PART 2 PRODUCTS

2.1 SINGLE DUCT, CONSTANT VOLUME AND VARIABLE VOLUME AIR TERMINAL UNITS

- A. Manufacturers:
  - 1. The Trane Co.
  - 2. Enviromental Technologies, Inc.
  - 3. Krueger
  - 4. Titus
  - 5. Price
- B. Product Description: Variable air volume terminal units for connection to central air systems, with electronic controls.
- C. Identification: Furnish each air terminal unit with identification label and airflow indicator. Include unit nominal airflow, maximum factory-set airflow and minimum factory-set airflow and coil type.
- D. Basic Assembly:
  - 1. Casings: Minimum 22 gage galvanized steel.
  - 2. Lining: Minimum 1 inch thick neoprene or vinyl coated glass fiber insulation, 1.5 lb./cu ft density, meeting NFPA 90A requirements and UL 181 erosion requirements.
  - 3. Plenum Air Inlets: Round stub connections for duct attachment.
  - 4. Plenum Air Outlets: S slip-and-drive connections.
- E. Basic Unit:
  - 1. Configuration: Air volume damper assembly inside unit casing. Locate control components inside protective metal shroud.
  - 2. Volume Damper: Construct of galvanized steel with peripheral gasket and self-lubricating bearings; maximum damper leakage: 2 percent of design air flow at 1 inches rated inlet static pressure.
  - 3. Mount damper operator to position damper normally open.
- F. Round Outlet: Discharge collar matching inlet size.
- G. Automatic Damper Operator:
  - 1. Electric Actuator: 24 volt with high limit.
- H. Sequence of Operation: Refer to Section 23 09 93.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify ductwork is ready for air terminal installation.

3.2 INSTALLATION

- A. Connect to ductwork in accordance with Section 23 31 00.
- B. Install ceiling access doors or locate units above easily removable ceiling components.
- C. Support units individually from structure. Do not support from adjacent ductwork.
- D. Support air terminal units connected by flexible duct independently of flexible duct.
- E. Install transition piece to match flexible duct size to inlet or outlet of variable air volume terminal.

3.3 MANUFACTURER'S FIELD SERVICES

- A. Division 1 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish services of factory trained representative for minimum of one day to start-up, calibrate controls, and instruct Owner on operation and maintenance.

3.4 ADJUSTING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for starting and adjusting.
- B. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to 0 percent full flow.

END OF SECTION 233600

SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Diffusers.
  - 2. Registers
  - 3. Grilles.
- B. Related Sections:
  - 1. Section 09 90 00 - Painting and Coating: Execution and product requirements for Painting of ductwork visible behind outlets and inlets specified by this section.
  - 2. Section 23 33 00 - Air Duct Accessories: Volume dampers for inlets and outlets.

1.2 REFERENCES

- A. Air Movement and Control Association International, Inc.:
  - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
- B. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 70 - Method of Testing for Rating the Performance of Air Outlets and Inlets.
- C. Sheet Metal and Air Conditioning Contractors:
  - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
- B. Product Data: Submit sizes, finish, and type of mounting. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.
- C. Test Reports: Rating of air outlet and inlet performance.
- D. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of air outlets and inlets.

1.5 QUALITY ASSURANCE

- A. Test and rate diffuser, register, and grille performance in accordance with ASHRAE 70.

1.6 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 GRILLES, REGISTERS, AND DIFFUSERS

- A. For all diffusers, grilles and registers, Noise Criteria (NC) shall not exceed 30 unless noted otherwise on drawings. NC rating shall be for diffuser/neck assembly.
- B. Refer to schedule on the drawings for manufacturer, materials, etc.
- C. Manufacturers:
  - 1. Titus.
  - 2. Metal Aire.
  - 3. Krueger.
  - 4. Price.
- D. Refer to schedule on drawings for diffuser type, materials, arrangements, etc.
- E. Refer to floor plans for quantity, neck size and flow rates.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. Verify inlet and outlet locations.
- C. Verify ceiling systems are ready for installation.

3.2 INSTALLATION

- A. Install diffusers to ductwork with airtight connection.
- B. Install balancing dampers on duct take-off to diffusers, grilles, and registers, whether or not dampers are furnished as part of diffuser, grille, and register assembly. Refer to Section 23 33 00.
- C. Paint visible portion of ductwork behind air outlets and inlets matte black. Refer to Section 09 90 00.

3.3 MATERIAL STORAGE ON-SITE

- A. All ductwork stored on-site should be elevated from the ground and sealed or covered to protect from moisture and dirt accumulation.



3.4 PROTECTION OF FINISHED WORK

- A. Immediately after installation, seal all supply, return and exhaust openings as well as all temporary ductwork openings not under immediate work (open ends in ductwork runs) with plastic.

3.5 INTERFACE WITH OTHER PRODUCTS

- A. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.

END OF SECTION 233700

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SECTION 237330 INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes modular factory fabricated air-handling units and accessories.
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for electric motors for placement by this section.
  - 3. Section 23 05 48 - Vibration Controls for HVAC Piping and Equipment: Product requirements for vibration isolators for placement by this section.
  - 4. Section 23 07 00 - HVAC Insulation: Product requirements for insulation for placement by this section.
  - 5. Section 23 09 00 - Direct-Digital Control System for HVAC: Controls remote from unit.
  - 6. Section 23 09 93 - Sequence of Operations for HVAC Controls: Sequences of operation applying to units in this section.
  - 7. Section 23 21 13 - Hydronic Piping: Product requirements for chilled water and hot water piping connections to air handling units.
  - 8. Section 23 21 16 - Hydronic Piping Specialties.
  - 9. Section 23 33 00 - Air Duct Accessories.
  - 10. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.

1.2 REFERENCES

- A. American Bearing Manufacturers Association:
  - 1. ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
  - 2. ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- B. Air Movement and Control Association International, Inc.:
  - 1. AMCA 99 - Standards Handbook.
  - 2. AMCA 210 - Laboratory Methods of Testing Fans for Aerodynamic Performance Rating.
  - 3. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
  - 4. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
  - 5. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.

- C. Air-Conditioning and Refrigeration Institute:
    - 1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
    - 2. ARI 430 - Central-Station Air-Handling Units.
    - 3. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.
  
  - D. National Electrical Manufacturers Association:
    - 1. NEMA MG 1 - Motors and Generators.
  
  - E. Sheet Metal and Air Conditioning Contractors:
    - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
  
  - F. Underwriters Laboratories Inc.:
    - 1. UL 900 - Air Filter Units.
    - 2. UL - Fire Resistance Directory.
- 1.3 SUBMITTALS
- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
  - B. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
  
  - C. Product Data, Submit the following:
    - 1. Published Literature: Indicate capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
    - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
    - 3. Fans: Performance and fan curves with specified operating point plotted, power, RPM.
    - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
    - 5. Dampers: Include leakage, pressure drop, and sample calibration curves. Indicate materials, construction, dimensions, and installation details.
    - 6. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring. Indicate factory installed and field installed wiring.
  
  - D. Samples: Submit two of each type of replacement filter media with frame.
  
  - E. Manufacturer's Installation Instructions: Submit.
  
  - F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
- B. Operation and Maintenance Data: Submit instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.5 QUALITY ASSURANCE

- A. Air Handling Units: Certify air volume, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430.
- B. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-91.
- C. Maintain one copy of each document on site.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience approved by manufacturer.

1.7 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
- B. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- C. Protect units from weather and construction traffic by storing in dry, roofed location.

1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.
- B. Furnish one year manufacturer warranty for air handling units.

1.10 EXTRA MATERIALS

- A. Section 01 70 00 - Execution and Closeout Requirements: Spare parts and maintenance products.
- B. Furnish one set of filters for each unit.

PART 2 PRODUCTS

2.1 AIR HANDLING UNITS

- A. Manufacturers:
  - 1. Daikin Vision Air Handler or approved equal by:
  - 2. Trane.
  - 3. York.

2.2 GENERAL

- A. Fabricate draw-thru type air handling units with fan sections.
- B. Factory fabricate air handling units of sizes, capacities, and configurations as scheduled on drawings
- C. Performance: Conform to AHRI 430.

2.3 UNIT CONSTRUCTION

- A. Fabricate unit with heavy gauge channel posts and panels secured with mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gasket.
- B. Panels and access doors shall be constructed as a 2-inch nominal thick; double wall assembly, injected with foam insulation with an R-value of not less than R-13.
  - 1. The inner liner shall be constructed of G90 galvanized steel.
  - 2. The outer panel shall be constructed of G90 galvanized steel.
  - 3. The floor plate shall be constructed as specified for the inner liner.
  - 4. Unit will be furnished with solid inner liners.
- C. Panel deflection shall not exceed L/240 ratio at 125% of design static pressure, maximum 5 inches of positive or 6 inches of negative static pressure. Deflection shall be measured at the panel midpoint.
- D. The casing leakage rate shall not exceed 0.50 cfm per square foot of casing surface area at design static pressure up to a maximum of +5" w.c. in positive pressure sections and -6" w.c. in negative pressure sections (.0025 m<sup>3</sup>/s per square meter of cabinet area at 1.24 kPa static pressure)

- E. Module to module field assembly shall be accomplished with an overlapping, full perimeter internal splice joint that is sealed with bulb type gasketing on both mating modules to minimize on-site labor and meet indoor air quality standards.
- F. Access doors shall be flush mounted to cabinetry, with minimum of two six inch long stainless steel piano-type hinges, latch and full size handle assembly. Access doors shall swing outward for unit sections under negative pressure. Access doors on positive pressure sections, shall have a secondary latch to relieve pressure and prevent injury upon access.
- G. A minimum 10-inch formed G60 galvanized steel base rail shall be provided by the unit manufacturer for structural rigidity and condensate trapping. The base rail shall be constructed with 12-gauge nominal. Base rail height shall be high enough to allow for proper drainage of condensate.
- H. Construct drain pans from stainless steel with cross break and double sloping pitch to drain connection. Provide drain pans under cooling coil section. Drain connection centerline shall be a minimum of 3" above the base rail to aid in proper condensate trapping. There must be minimum 2" thickness of insulation under drain pan.

#### 2.4 FAN ASSEMBLIES

- A. Fan assembly shall include fan, fan base and motor; and shall be dynamically balanced by the fan manufacturer.
- B. Acceptable fan assembly shall be a single width, single inlet, class II, direct-drive type plenum fan dynamically balanced as an assembly. Maximum fan RPM shall be below first critical fan speed. Fan assemblies shall be dynamically balanced by the manufacturer on all three planes. Provide access to motor and fan assembly through hinged access door.
- C. Fan and motor shall be mounted internally on a steel base. Factory mount motor on slide base that can be slid out the side of the unit if removal is required. Provide access to motor, drive, and bearings through hinged access door. Fan and motor assembly shall be mounted on 2" deflection spring vibration type isolators inside cabinetry. Seismic snubbers shall be provided.

#### 2.5 BEARINGS, SHAFTS, AND DRIVES

- A. Bearings: Basic load rating computed in accordance with AFBMA - ANSI Standards. The bearings shall be provided on the motor with the fan wheel mounted directly on the motor shaft, AMCA arrangement 4.
- B. Shafts shall be solid, hot rolled steel, ground and polished, keyed to shaft, and protectively coated with lubricating oil. Hollow shafts are not acceptable.
- C. The fan wheel shall be direct coupled to the motor shaft. The wheel width shall be determined by motor speed and fan performance characteristics.

2.6 ELECTRICAL

- A. Fan motors shall be manufacturer provided and installed, Open Drip Proof, premium efficiency (meets or exceeds EPAAct requirements).
- B. Wiring Termination: Provide terminal lugs to match branch circuit conductor quantities, sizes, and materials indicated. Enclosed terminal lugs in terminal box sized to NFPA 70.

2.7 COOLING AND HEATING COILS

- A. Certification: Acceptable water cooling and water heating coils shall be certified in accordance with AHRI Standard 410 and bear the AHRI label.
- B. Water cooling coil shall be provided. Provide access to coil(s) for service and cleaning. Enclose coil headers and return bends fully within unit casing. Unit shall be provided with coil connections that extend a minimum of 5" beyond unit casing for ease of installation. Drain and vent connections shall be provided exterior to unit casing. Coil connections must be factory sealed with grommets on interior and exterior panel liners to minimize air leakage and condensation inside panel assembly. If not factory packaged, Contractor must supply all coil connection grommets and sleeves. Coils shall be removable through side and/or top panels of unit without the need to remove and disassemble the entire section from the unit.
- C. Headers shall consist of seamless copper tubing to assure compatibility with primary surface. Headers to have intruded tube holes to provide maximum brazing surface for tube to header joint, strength, and inherent flexibility. Header diameter should vary with fluid flow requirements.
- D. Fins shall have a minimum thickness of 0.0075 inch aluminum plate construction. Fins shall have full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer. Tubes shall be mechanically expanded into the fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Bare copper tubes shall not be visible between fins.
- E. Coil tubes shall be 5/8 inch OD seamless copper, 0.020 inch nominal tube wall thickness, expanded into fins, brazed at joints.
- F. Coil connections shall be carbon steel, NPT threaded connection. Connection size to be determined by manufacturer based upon the most efficient coil circuiting. Vent and drain fittings shall be furnished on the connections, exterior to the air handler. Vent connections provided at the highest point to assure proper venting. Drain connections shall be provided at the lowest point to insure complete drainage and prevent freeze-up.
- G. Coil casing shall be a formed channel frame of galvanized steel.



2.8 FILTERS

- A. Provide side loading and removal of filters.
- B. Filter media shall be UL 900 listed, Class I or Class II.

2.9 ADDITIONAL SECTIONS

- A. Access section shall be provided for access between components.
- B. Plenum section shall be provided and properly sized for inlet and/or discharge air flow (between 600 and 1500 feet per minute). The plenum shall provide single or multiple openings as shown on drawings and project schedule.

2.10 ENERGY RECOVERY WHEELS

- A. Energy recovery wheels shall be constructed of corrugated synthetic fibrous media, with a desiccant intimately bound and uniformly and permanently dispersed throughout the matrix structure of the media. Rotors with desiccants coated bonded, or synthesized onto the media are not acceptable due to delaminating or erosion of the desiccant material. Media shall be synthetic to provide corrosion resistance and resistance against attack from standard chemicals. Face flatness of the wheel shall be maximized in order to minimize wear on inner seal surfaces and to minimize cross leakage. Rotor shall be constructed of alternating layers of flat and corrugated media. Wheel layers should be uniform in construction forming uniform aperture sizes for airflow. Wheel construction shall be fluted or formed honeycomb geometry so as to eliminate internal wheel bypass. Wheel layers that can be separated or spread apart by airflow are unacceptable due to the possibility of channeling and performance degradation.
- B. Desiccant Material: The desiccant material shall be a molecular sieve, and specifically a 4A or smaller molecular sieve to minimize cross contamination.
- C. Wheel Media Support System: The wheel frames shall consist of evenly spaced steel spokes, galvanized steel outer band and rigid center hub. The wheel construction should allow for post fabrication wheel alignment. Wheel Seals: The wheel seals shall be full contact nylon brush seals or equivalent. Seals should be easily adjustable. Wheel cassette: Cassettes shall be fabricated of heavy duty reinforced galvanized steel or welded structural box tubing. Cassettes shall have a built in adjustable purge section minimizing cross contamination of supply air as shown on unit schedule.
- D. Bearings shall be inboard, zero maintenance, permanently sealed roller bearings, or alternatively, external flanged or pillow block bearings.
- E. Drive systems shall consist of fractional horsepower AC drive motors with multi-link drive belts. Face and bypass dampers shall be furnished as shown on unit schedule and drawings

- F. Certification: The wheel shall be AHRI certified by the energy recovery wheel supplier to AHRI Standard 1060 and must bear the AHRI certification stamp. Private independent testing performed "in accordance with" various standards is not a substitute for AHRI certification and shall not be accepted. The wheel shall be listed or recognized by UL or equivalent.
- G. Frost Control. Frost prevention shall be achieved using outside air bypass. The air handler manufacturer shall provide frost set point temperatures, based on the scheduled design air conditions. The air handler manufacturer shall provide any de-rate in performance due to frost prevention measures for winter design supply and exhaust air conditions leaving the energy wheel.

## 2.11 CONTROLS

- A. DDC Control Products: Refer to Section 23 09 23.
- B. Sequences of Operation: Refer to Section 23 09 93.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify concrete house keeping pad are installed and dimensions are adequate and as shown on shop drawings.

### 3.2 INSTALLATION

- A. Install in accordance with ARI 430.
- B. Contractor shall level all unit sections in accordance with the unit manufacturer's instructions and shall provide and install all necessary permanent shim material to ensure individual sections and entire assembled units are level
- C. Install flexible connections between unit and inlet and discharge ductwork. Install metal bands of connectors parallel with minimum 1 inch flex between ductwork and fan while running. Refer to Section 23 33 00.
- D. Install assembled units with vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as indicated required. Adjust snubbers to prevent tension in flexible connectors when fan is operating. Refer to Section 23 05 48.
- E. Install condensate piping with trap and route from drain pan to nearest floor drain. Refer to Section 23 21 13.

- F. Provide fixed sheaves required for final air balance.
  - G. Insulate coil headers located outside airflow as specified for piping. Refer to Section 23 07 00.
- 3.3 INSTALLATION CHILLED WATER COOLING COIL
- A. Make connections to coils with unions or flanges.
  - B. Connect water supply to leaving airside of coil (counter flow arrangement).
  - C. Locate water supply at bottom of supply header and return water connection at top.
  - D. Install water coils to allow draining and install drain connection at low points.
  - E. Install valves and piping specialties in accordance with details as indicated on Drawings.
  - F. Install automatic air vents at high points complete with shutoff valve. Refer to Section 23 21 13.
  - G. Install chilled water piping accessories within unit casing.
- 3.4 INSTALLATION HOT WATER HEATING COIL
- A. Make connections to coils with unions or flanges.
  - B. Connect water supply to leaving airside of coil (counter flow arrangement).
  - C. Locate water supply at bottom of supply header and return water connection at top.
  - D. Install water coils to allow draining and install drain connection at low points.
  - E. Install valves and piping specialties in accordance with details as indicated on Drawings.
  - F. Install automatic air vents at high points complete with shutoff valve. Refer to Section 23 21 13.
  - G. Install hot water piping accessories within unit casing.
- 3.5 MANUFACTURER'S FIELD SERVICES
- A. Section 01 40 00 - Quality Requirements: Requirements for manufacturer's field services.
  - B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.

3.6 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Install temporary filters during construction period. Replace with permanent filters at Substantial Completion.

3.7 DEMONSTRATION

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative for one 8 hour day to instruct Owner's personnel in operation and maintenance of units. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.

3.8 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Do not operate units until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 237330

SECTION 238146 WATER SOURCE UNITARY HEAT PUMPS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Water to Water Heat Pumps
  
- B. Related Sections:
  - 1. Division 01 – General Commissioning Requirements for commissioning requirements related to this division.
  - 2. Section 23 0400 – General Conditions for Mechanical Trades
  - 3. Section 23 0548 - Vibration Controls for HVAC Piping and Equipment: Product requirements for vibration isolators installed by this section.
  - 4. Section 23 0900 - Direct-Digital Control System for HVAC: Controls remote from unit.
  - 5. Section 23 2113 - Hydronic Piping: Water and drain piping connections.
  - 6. Division 26 - Equipment Wiring Connections: Electrical connection to units.

1.2 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
  - 1. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
  - 2. ARI 350 - Sound Rating of Non-Ducted Indoor Air Conditioning Equipment.
  
- B. Air Movement and Control Association International, Inc.:
  - 1. AMCA 500 - Test Methods for Louvers, Dampers, and Shutters.
  
- C. American Society of Heating, Refrigerating and Air-Conditioning Engineers:
  - 1. ASHRAE 90.1 - Energy Standard for Buildings Except Low-Rise Residential Buildings.
  
- D. ASTM International:
  - 1. ASTM B117 - Standard Practice for Operating Salt Spray (Fog) Apparatus.
  
- E. International Organization for Standardization:
  - 1. ISO 13256-1 - Water-Source Heat Pumps - Testing and Rating for Performance - Part 1: Water-to-Air and Brine-to-Air Heat Pumps.
  
- F. National Electrical Manufacturers Association:
  - 1. NEMA WD 6 - Wiring Devices-Dimensional Requirements.
  
- G. National Fire Protection Association:
  - 1. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems.
  
- H. Underwriters Laboratories, Inc.:
  - 1. UL 1995 - Heating and Cooling Equipment.

1.3 DEFINITIONS

- A. Coefficient of Performance (COP), heat pump, heating - Ratio of rate of heat delivered to rate of energy input, in consistent units, for complete heat pump system, including compressor and, if applicable, auxiliary heat, under designated operating conditions.
- B. Energy Efficiency Ratio (EER) - Ratio of net cooling capacity in Btuh to total rate of electric input in watts under designated operating conditions.

1.4 SUBMITTALS

- A. Division 1 - Submittal Procedures: Requirements for submittals.
- B. Product Data: Submit data indicating:
  - 1. Cooling and heating capacities at scheduled water flow and temperatures.
  - 2. Dimensions.
  - 3. Rough-in connections and connection requirements.
  - 4. Controls.
  - 5. Accessories.
  - 6. Installation, operation and service clearances. Indicate lift points and recommendations and center of gravity.
  - 7. Indicate unit shipping, installation and operating weights.
  - 8. Submit data on electrical requirements and connection points. Include recommended wire and fuse sizes or maximum circuit ampacity.
- C. Test Reports: Submit results of factory test at time of unit shipment.
- D. Manufacturer's Installation Instructions: Submit assembly, support details, connection requirements, and include start-up instructions and completed checklists.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- F. Manufacturer's Field Reports: Submit start-up report for each unit.

1.5 CLOSEOUT SUBMITTALS

- A. Division 1 - Execution and Closeout Requirements: Requirements for submittals.
- B. Project Record Documents: Record actual locations of controls installed remotely from units.
- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data. Include parts list and wiring diagrams.

1.6 QUALITY ASSURANCE

- A. Cooling Performance Requirements: Conform to minimum EER prescribed by ASHRAE 90.1 when tested in accordance with ISO 13256-1 and UL 1995.
- B. Heating Performance Requirements: Conform to minimum COP prescribed by ASHRAE 90.1 when tested in accordance with ISO 13256-1 and UL 1995.
- C. Sound Rating: Measure in accordance with ARI 270 ARI 260 ARI 350.
- D. Insulation and adhesives: Meet requirements of NFPA 90A.
- E. Maintain one copy of each document on site.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum years experience approved by manufacturer.

1.8 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept units on site. Inspect for damage.
- C. Comply with manufacturers installation instructions for rigging, unloading and transporting units.
- D. Protect units from damage by storing in manufacturer's packaging until ready for installation.

1.10 COORDINATION

- A. Division 1 - Administrative Requirements: Requirements for coordination.
- B. Coordinate unit installation with rigging, piping systems, mechanical room layouts and access requirements.

1.11 WARRANTY

- A. Division 1 - Execution and Closeout Requirements: Requirements for warranties.
- B. Warranty:
  - 1. Extended 4-year compressor warranty covers compressor for a total of 5 years.
  - 2. Extended 4-year refrigeration circuit warranty covers coils, reversing valve, expansion valve and compressor for a total of 5 years.

PART 2 PRODUCTS

2.1 WATER TO WATER HEAT PUMPS

- A. Manufacturers:
  - 1. Climate Master
  - 2. Daikin
  - 3. Florida Heat Pump
- B. System Description: Heat Pump shall incorporate Scroll-type compressors and consist of multiple refrigerant circuits. Each refrigerant circuit shall consist of an individual compressor, condenser, evaporator circuit, thermal expansion valve, reversing valve, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit heat pump must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits.
- C. Operating Conditions:
  - 1. Provide water-to-water heat pump with the capacity as scheduled on drawings.
  - 2. Heat Pump shall be designed to operate using R-410a Refrigerant.
  - 3. Heat Pump shall be designed for parallel evaporator water flow.
  - 4. The liquid to be heated and cooled will be water containing corrosion inhibitors.
- D. General: Furnish and install Water-Source Heat Pumps as indicated on the plans. Equipment shall be completely assembled, piped and internally wired. Capacities and characteristics as listed in the schedule and the specifications that follow.
  - 1. Units shall be supplied completely factory built capable of operating over an entering water temperature range from 20° to 120°F (-6.7° to 48.9°C) as standard. Equivalent units from other manufacturers may be proposed provided approval to bid is given 10 days prior to bid closing. All equipment listed in this section must be rated in accordance with Air-Conditioning, Heating and Refrigeration Institute/International Standards Organization (AHRI/ISO 13256-2). All equipment must be tested, investigated, and determined to comply with the requirements of the standards for Heating and Cooling Equipment UL-1995 for the United States and CAN/CSA-C22.2 NO.236 for Canada, by Intertek Testing Laboratories (ETL). The units shall have AHRI/ISO and ETL-US-C labels.



2. All units shall pass a factory acceptance test. The quality control system shall automatically perform factory acceptance test via computer. A detailed report card from the factory acceptance test shall ship with each unit. (Note: If unit fails the factory acceptance test, it shall not be allowed to ship. Unit serial number shall be recorded by factory acceptance test and furnished on report card for ease of unit warranty status.)
- E. Basic Construction:
1. All units must have multiple removable panels for serviceability of compressor compartment. Units having only one access panel shall not be acceptable.
  2. The heat pumps shall be fabricated from heavy gauge galvanized steel with powder coat paint finish. Both sides of the steel shall be painted for added protection. All interior surfaces shall be lined with 1/2 inch (12.7mm) thick, 1-1/2 lb/ft<sup>3</sup> (24 kg/m<sup>3</sup>) acoustic type glass fiber insulation. Insulation placement shall be designed in a manner that will eliminate any exposed edges.
  3. Standard cabinet panel insulation must meet NFPA 90A requirements, air erosion and mold growth limits of UL-181, stringent fungal resistance test per ASTM-C1071 and ASTM G21, and shall meet zero level bacteria growth per ASTM G22.
  4. Cabinets shall have separate holes and knockouts for entrance of line voltage and low voltage control wiring. All factory-installed wiring passing through factory knockouts and openings shall be protected from sheet metal edges at openings by plastic ferrules. Supply and return water connections shall be copper FPT fittings. Contractor must ensure that units can be easily removed for servicing and coordinate locations of electrical conduit and lights with the electrical contractor.
  5. Unit(s) shall have exterior indicator lights showing, 1) compressor operation (on/off) and 2) unit "fault" status. Contractor shall be responsible for providing control circuitry and indicator lights for units not providing this feature.
  6. Sound Attenuating: Provide sound attenuating insulation on units
- F. Refrigerant Circuit:
1. Units shall have sealed, isolated refrigerant circuit(s), each including a high efficiency scroll compressor designed for heat pump operation, a thermostatic expansion valve for refrigerant metering, a reversing valve, load and source coaxial (tube in tube) refrigerant to water heat exchangers, and safety controls including a high pressure switch, low pressure switch (loss of charge), and low water temperature sensors. Access fittings shall be factory installed on high and low pressure refrigerant lines to facilitate field service. Activation of any safety device shall prevent compressor operation via a microprocessor lockout circuit.
  2. Unit shall be supplied with extended range insulation, which adds closed cell insulation to internal water lines, and provides insulation on suction side refrigeration tubing including refrigerant to water heat exchangers.
  3. Hermetic compressors shall be internally sprung. The compressors shall have a dual level vibration isolation system. The compressors will be mounted on specially engineered sound-tested EPDM vibration isolation grommets to a large heavy gauge compressor mounting plate, which is then isolated from the cabinet base with rubber grommets for maximized vibration attenuation. Compressors shall have thermal overload protection.

4. Refrigerant to water heat exchangers shall be of copper inner water tube and steel refrigerant outer tube design, rated to withstand 625 PSIG (4309 kPa) working refrigerant pressure and 450 PSIG (3101 kPa) working water pressure. The refrigerant to water heat exchanger shall be “electro-coated” with a low cure cathodic epoxy material a minimum of 0.4 mils thick (0.4 – 1.5 mils range) on all surfaces. The black colored coating shall provide a minimum of 1000 hours salt spray protection per ASTM B117-97 on all external steel and copper tubing. The material shall be formulated without the inclusion of any heavy metals and shall exhibit a pencil hardness of 2H (ASTM D3363-92A), crosshatch adhesion of 4B-5B (ASTM D3359-95), and impact resistance of 160 in-lbs (184 kg-cm) direct (ASTM D2794-93).
5. Option: The unit will be supplied with cupro-nickel coaxial water to refrigerant heat exchanger (specify source and/or load heat exchanger).

G. Electrical:

1. A control box shall be located within the unit compressor compartment and shall contain a 75VA transformer, 24 volt activated, 3 pole compressor contactor, terminal block for thermostat wiring and solid-state controller for complete unit operation. Reversing valve wiring shall be routed through this electronic controller. Units shall be name-plated for use with time delay fuses or HACR circuit breakers. Unit controls shall be 24 Volt and provide heating or cooling as required by the remote aquastat / sensor. Units with two compressors (120 and 340) shall have a solid-state time delay relay and random start to prevent both compressors from starting simultaneously.

H. Solid State Control System:

1. Units shall have a solid-state control system. Units utilizing electro-mechanical control shall not be acceptable. The control system microprocessor board shall be specifically designed to protect against building electrical system noise contamination, EMI, and RFI interference. The control system shall interface with a heat pump type thermostat. The control system shall have the following features:
  - a. Anti-short cycle time delay on compressor operation.
  - b. Random start on power up mode.
  - c. Low voltage protection.
  - d. High voltage protection.
  - e. Unit shutdown on high or low refrigerant pressures.
  - f. Unit shutdown on low water temperature.
  - g. Condensate overflow electronic protection.
  - h. Option to reset unit at thermostat or disconnect.
  - i. Automatic intelligent reset. Unit shall automatically reset the unit 5 minutes after trip if the fault has cleared. If a fault occurs 3 times sequentially without thermostat meeting temperature, then lockout requiring manual reset will occur.
  - j. Ability to defeat time delays for servicing.
  - k. Light emitting diode (LED) on circuit board to indicate high pressure, low pressure, low voltage, high voltage, low water/air temperature cut-out, condensate overflow, and control voltage status.

- l. The low-pressure switch shall not be monitored for the first 120 seconds after a compressor start command to prevent nuisance safety trips.
  - m. 24V output to cycle a motorized water valve or other device with compressor contactor.
  - n. Unit Performance Sentinel (UPS). The UPS warns when the heat pump is running inefficiently.
  - o. Water coil low temperature sensing (selectable for water or anti-freeze).
  - p. Air coil low temperature sensing.
- I. Enhanced solid state control system (DXM)
- 1. This control system features two stage control of cooling and two stage control of heating modes for exacting temperature and dehumidification purposes.
  - 2. This control system coupled with a multi-stage thermostat will better dehumidify room air by automatically running the heat pump's fan at lower speed on the first stage of cooling thereby implementing low sensible heat ratio cooling. On the need for higher cooling performance the system will activate the second stage of cooling and automatically switch the fan to the higher fan speed setting. This system may be further enhanced with a humidistat. Units not having automatic low sensible heat ratio cooling will not be accepted; as an alternate a hot gas reheat coil may be provided with control system for automatic activation.
  - 3. Control shall have all of the above-mentioned features of the control system along with the following expanded features:
    - a. Night setback control.
    - b. Random start on return from night setback.
    - c. Minimized reversing valve operation (Unit control logic shall only switch the reversing valve when cooling is demanded for the first time. The reversing valve shall be held in this position until the first call for heating, ensuring quiet operation and increased valve life.).
    - d. Override temperature control with 2-hour timer for room occupant to override setback temperature at the thermostat.
    - e. Dry contact night setback output for digital night setback thermostats.
    - f. Ability to work with heat pump or heat/cool (Y, W) type thermostats.
    - g. Ability to work with heat pump thermostats using O or B reversing valve control.
    - h. Emergency shutdown contacts.
    - i. Ability to allow up to 3 units to be controlled by one thermostat.
    - j. Relay to operate an external damper.
    - k. Ability to automatically change fan speed from multistage thermostat.
    - l. Relay to start system pump.
    - m. 75 VA control transformer. Control transformer shall have load side short circuit and overload protection via a built in circuit breaker.
- J. Control Interface system
- 1. Units shall have all the features listed above the control board will be supplied with a Multiple Protocol interface board. Available protocols are BACnet MS/TP, or Modbus. The choice of protocol shall be field selectable/changeable via the use of a simple selector switch and shall be coordinated with BMS contractor. Protocol selection shall not require any additional programming or special external hardware or software tools. This will permit all units to be daisy

chain connected by a 2-wire twisted pair shielded cable. The following points must be available at a central or remote computer location:

- a. Source leaving water temperature
- b. Load leaving water temperature
- c. Command of space temperature setpoint
- d. Cooling status
- e. Heating status
- f. Low temperature sensor alarm
- g. Low pressure sensor alarm
- h. High pressure switch alarm
- i. Hi/low voltage alarm
- j. Unoccupied/occupied command
- k. Cooling command
- l. Heating command
- m. Fault reset command
- n. Itemized fault code revealing reason for specific shutdown fault (any one of 7)

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify concrete housekeeping pad is sized and located correctly.
- C. Verify piping rough-in is at correct location.
- D. Verify electrical rough-in is at correct location.

#### 3.2 INSTALLATION

- A. Level and shim units, and anchor to structure. Install units on vibration isolators. Refer to Section 23 05 48.
- B. Install hydronic piping accessories on condenser water piping furnished with unit.
- C. Piping System Flushing Procedure
  1. Prior to connecting the heat pump to the condenser and chilled water loop, the piping loops shall be flushed with a detergent and hot water (110-130° F) mixture to remove previously accumulated dirt and other organic. In old piping systems with heavy encrustation of inorganic materials consult a water treatment specialist for proper passivation and/or removal of these contaminants.
  2. During the flushing 30 mesh (max.) Y-strainers (or acceptable equivalent) shall be in place in the system piping and examined periodically as necessary to remove collected residue. The flushing process shall take no less than 6 hours or until the strainers when examined after each flushing are clean. Old systems with

heavy encrustation shall be flushed for a minimum of 24 hours and may take as long as 48 hours before the filters run clean. Detergent and acid concentrations shall be used in strict accordance with the respective chemical manufacturers instructions. After flushing with the detergent and/or dilute acid concentrations the system loop shall be purged with clean water for at least one hour to ensure that all residual cleaning chemicals have been flushed out.

3. Prior to supplying water to the heat pump the Water Treatment Specification shall be consulted for requirements regarding the water quality during heat pump operation. The appropriate heat pump manufacturer's service literature shall be available to the operator and/or service contractor and consulted for guidelines concerning preventative maintenance and off-season shutdown procedures.

### 3.3 INSTALLATION

- A. Install the following piping accessories on condenser water piping connections. Refer to Section 23 21 13.
- B. On inlet:
  - a. Thermometer well for temperature limit controller.
  - b. Thermometer well and thermometer.
  - c. Strainer.
  - d. Flow switch.
  - e. Pressure gage.
  - f. Shut-off valve.
2. On outlet:
  - a. Thermometer well and thermometer.
  - b. Pressure gage.
  - c. Shut-off and balancing valve.
- C. Install manual air vents at high points complete with shutoff valve. Refer to Section 23 21 13.
- D. Install components furnished loose for field mounting.
- E. Install electrical devices furnished loose for field mounting.
- F. Install control wiring between unit and field installed accessories.

### 3.4 PROTECTION OF FINISHED WORK

- A. Division 1 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect finished surfaces of cabinets with protective covers during remainder of construction.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Division 1 - Quality Requirements: Requirements for manufacturer's field services.
- B. Furnish initial start-up and shutdown during first year of operation, including routine servicing and checkout.
- C. Furnish services of manufacturer's technical representative for two 8 hour days to instruct Owner's personnel in operation and maintenance of units and to supervise startup testing. Schedule training with Owner.

3.6 CLEANING

- A. Division 1 - Execution and Closeout Requirements: Requirements for cleaning.
- B. Vacuum clean coils and inside of unit cabinet.
- C. Touch up marred or scratched surfaces of factory finished cabinets, using finish materials furnished by manufacturer.

3.7 DEMONSTRATION

- A. Division 1 - Execution and Closeout Requirements: Requirements for demonstration and training.
- B. Demonstrate unit operation and maintenance.
- C. Furnish services of manufacturer's technical representative as described in manufacturers field services above for a period of 8 hours.

END OF SECTION 238146

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SECTION 238200 - HYDRONIC UNITS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Fin tube radiation.
  - 2. Cabinet unit heaters.
  - 3. Unit heaters.
  - 4. Radiant floor heating.
  - 5. Wall mounted chilled water AC unit.
  
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
  - 3. Section 23 07 00 - HVAC Insulation: Execution requirements for insulation specified by this section.
  - 4. Section 23 21 13 - Hydronic Piping: Execution requirements for connection of chilled water, hot water, and drain piping to units specified by this section.
  - 5. Section 23 21 16 - Hydronic Piping Specialties: Product requirements for hydronic piping specialties for placement by this section.
  - 6. Section 23 31 00 - HVAC Ducts and Casings: Execution requirements for ducts specified by this section.
  - 7. Section 26 05 03 - Equipment Wiring Connections: Execution requirements for electric connection to units specified by this section.

1.2 REFERENCES

- A. Air-Conditioning and Refrigeration Institute:
  - 1. ARI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils.
  
- B. Sheet Metal and Air Conditioning Contractors:
  - 1. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Submittal procedures.
  
- B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.
  
- C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.

- D. Radiant Floor Shop Drawings:
    - 1. Provide details for installation of piping and manifolds.
    - 2. Provide layout drawings of piping and manifolds at minimum 1/8" scale.
    - 3. Provide schedule of each circuit including pipe size, spacing, pipe length, flow rate and pressured drop.
    - 4. Provide heat loss summary data (BTUH).
  - E. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.
  - F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- 1.4 CLOSEOUT SUBMITTALS
- A. Section 01 70 00 - Execution and Closeout Requirements: Closeout procedures.
  - B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access to valves.
  - C. Operation and Maintenance Data: Submit manufacturers descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.
- 1.5 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
  - B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.
- 1.6 PRE-INSTALLATION MEETINGS
- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
  - B. Convene minimum one week prior to commencing work of this section.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Section 01 60 00 - Product Requirements: Product storage and handling requirements.
  - B. Accept units on site in factory packing. Inspect for damage. Store under roof.
  - C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.
- 1.8 FIELD MEASUREMENTS
- A. Verify field measurements prior to fabrication.



1.9 WARRANTY

- A. Section 01 70 00 - Execution and Closeout Requirements: Product warranties and product bonds.

PART 2 PRODUCTS

2.1 FIN TUBE RADIATION

- A. Manufacturers:
  - 1. Modine / Airedale
  - 2. Vulcan
  - 3. Slant Fin
  - 4. Sterling
  - 5. Rittling.
- B. Heating Elements: Seamless copper tubing, mechanically expanded into evenly spaced aluminum fins, suitable for soldered fittings.
- C. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- D. Enclosures: 0.0478 inch thick steel up to 18 inches in height, 0.598 inch steel over 18 inches in height, with easily jointed components for wall to wall installation. Support rigidly, on wall or floor mounted brackets at least 3 feet on center maximum.
- E. Finish: Factory applied baked enamel of color as selected.
- F. Damper: Where heating media is not thermostatically controlled, furnish knob-operated internal damper at enclosure air outlet.
- G. Access Doors: For otherwise inaccessible valves, furnish factory-made permanently hinged access doors, 6 x 7 inch minimum size, integral with cabinet.

2.2 CABINET UNIT HEATERS

- A. Manufacturers:
  - 1. Modine / Airedale
  - 2. Airedale
  - 3. Vulcan
  - 4. Sterling
  - 5. Rittling
- B. Coils: Seamless copper tubing with evenly spaced aluminum fins mechanically bonded to tubing. Coils shall be leak tested to minimum 200 psig, air under water.
- C. Front panel: 16 gage steel with sound dampening insulation and tamper resistant locks.

- D. Finish: Factory applied baked enamel finish.
- E. Fans: Direct-drive, centrifugal, statically and dynamically balanced.
- F. Access area: Open area at each end of cabinet for electrical wiring and piping accessories. Provide with access door.
- G. Accessories: Provide permanent aluminum filter. For wall mounted unit, provide wall gasketing seal for recessed units. For floor mounted units, provide leveling legs for non recessed units.

### 2.3 UNIT HEATERS

- A. Manufacturers:
  - 1. Modine / Airedale
  - 2. Vulcan
  - 3. Sterling
  - 4. Rittling
- B. Coils: Seamless copper tubing, 0.025 inch minimum wall thickness, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Casing: 0.0478-inch thick steel with threaded pipe connections for hanger rods.
- D. Finish: Factory applied baked enamel of color as selected.
- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- F. Air Outlet: Adjustable pattern diffuser on projection models and two four-way louvers on horizontal throw models.
- G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Section 23 05 13.
- H. Control: Local multi-speed disconnect switch.

### 2.4 RADIANT FLOOR HEATING SYSTEMS

- A. Manufacturers:
  - 1. Viega
  - 2. Uponor
  - 3. Watts
  - 4. REHAU

- B. Stainless Manifold with Pumps, Valves and Accessories
    - 1. Manifolds shall be made of 304 Stainless Steel with nickel-plate valve necks.
    - 2. Circulating pump shall be in line with ECM motor and 7 pre-set factory speeds.
    - 3. Balancing valves, flow meters and shut off valves shall be integrated on manifold. Each circuit shall have individual shut-off valves, balance valves and flow meters
    - 4. Three way valve shall be modulating wit 0-10VDC input signal from BMS.
    - 5. Air bleeders and purge valves shall be integrated on manifold.
    - 6. Manifolds shall include 1" NPT removable end caps and 1 ¼" union connections.
    - 7. Provide with galvanized steel support bracket.
    - 8. Flow Meters
      - a. Visual Flow Indicator: Visible indication in a clear plastic cap at top of valve.
      - b. Body Brass: Nickel plated.
      - c. Measure range: 0 - 2 gpm.
    - 9. Thermometers shall be stainless steel, 2 inch diameter. Accuracy shall be plus or minus 2 percent of range.
    - 10. Maximum Operating Pressure: 100 psi.
    - 11. Maximum Operating Temperature: 180 deg F.
    - 12. Manual Air Vents shall be brass body, nickel-plated.
  - C. Cabinet:
    - 1. 20 gauge galvanized steel metal with epoxy polyester powered coating.
    - 2. Recessed with adjustable legs and locking mechanism.
    - 3. Interior dimensions shall be 45"x28"x6" deep.
    - 4. Cabinet shall house manifold, valves, pumps and accessories.
  - D. Cable Ties:
    - 1. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
    - 2. Minimum Width: 0.17 inch.
    - 3. Tensile Strength: 75 lb, minimum.
- 2.5 AC-1 AIR CONDITIONING UNIT - CHILLED WATER
- A. Manufacturers:
    - 1. Modine
    - 2. Multi-Aqua
    - 3. EMI
  - B. Construction: Wall mounted unit. Casing shall be manufactured from lightweight galvanized sheet steel with integral fan mounting rails for added strength. Fire resistant foam insulation shall be fitted internally to provide both thermal and acoustic insulation.
  - C. Chilled Water shall utilize large surface area coils positioned to optimize heat transfer and airflow. Each coil is manufactured from copper tubes with mechanically bonded aluminum fins and are circuited from headers to ensure low water pressure drops.

- D. Fans shall be backward curved centrifugal fans, statically and dynamically balanced for quiet operation. Fan impellers are made from either aluminum or fire retardant plastic (UL94 VO) for light weight and corrosion resistant operation. Fans shall be driven by an enclosed multispeed external rotor motor. Fans come complete with thermal overload protection and sealed-for-life lubricated bearings.
- E. Filtration Wire framed filters shall be fitted and shall be re-usable and may be vacuum cleaned. Provide one extra set of filters for each unit.
- F. Condensate Pump and check valve shall be factory provided and wired. The pump shall be fixed to a mounting bracket which can be withdrawn from the side of the chassis and incorporates an inspection hole to allow a visual check of the pump during operation. A float switch is fitted to stop the cooling action should the pump becomes blocked or fail.
- G. Alarm Status Relay: The unit shall include a relay for unit failure notification. Normally open contact available for field connection to BMS.
- H. Start / Stop Terminals: The unit shall include terminals for remote start/stop of the unit through the BMS. The unit is enabled when contact between the terminals is closed.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Coordination and project conditions.
- B. For recessed units, verify recess dimensions are correct size.
- C. Verify wall construction is ready for installation.
- D. Verify ductwork is ready for installation.
- E. Verify concealed blocking and supports are in place and connections are correctly located.

#### 3.2 INSTALLATION

- A. Install air coils in ducts and casings in accordance with SMACNA HVAC Duct Construction Standards, Metal and Flexible. Refer to Section 23 31 00.
- B. Duct Mounted Coils: Support air coil sections independent of piping on steel channel or double angle frames and secure to casings. Furnish frames for maximum three coil sections. Arrange supports to avoid piercing drain pans. Install with airtight seal between coil and duct or casing.
- C. Supports for Hung Equipment including duct mounted coils, unit heaters, cabinet unit heaters and radiant ceiling panels: Provide vibration isolation and seismic supports per Specification Section 23 0548. Support equipment independent of piping.

- D. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- E. Install coils level. Install cleanable tube fluid coils and level frame steam coils with 1: 50 pitch.
- F. Make connections to coils with unions and flanges.
- G. On water coils, install shut-off valve on supply piping and lockshield balancing valve on return piping. Locate water supply at bottom of supply header and return water connection at top. Install manual float operated automatic air vents at high points complete with stop valve. Install water coils to be drainable and install drain connection at low points. Refer to Section 23 21 13.
- H. On water and glycol heating coils, and chilled water cooling coils, connect water supply piping to leaving airside of coil (counter flow arrangement). Refer to Section 23 21 13.
- I. Install insulation air coil casings. Refer to Section 23 07 00.
- J. Insulate headers located outside airflow, insulate as specified for piping. Refer to Section 23 07 00.
- K. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.
- L. Protection: Install finished cabinet units with protective covers during remainder of construction.
- M. Fin Tube Radiation: Locate on outside walls and run cover wall-to-wall unless otherwise indicated. Center elements under windows. Where multiple windows occur over units, divide element into equal segments centered under each window. Align cabinet joints with window mullions. Install wall angles where units butt against walls.
- N. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- O. Hydronic Units: Install with shut-off valve on supply piping and lockshield balancing valve on return piping. Where not accessible, extend vent to exterior surface of cabinet for servicing. For cabinet unit heaters, fan coil units, and unit heaters, install float operated automatic air vents with stop valve. Refer to Section 23 21 13.

3.3 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Final cleaning.
- B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.
- D. Install new filters.

END OF SECTION 238200

## SECTION 238208 - ELECTRIC HEATING UNITS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Finned tube / baseboard radiation.
  - 2. Cabinet unit heaters.
- B. Related Sections:
  - 1. Section 23 04 00 – General Conditions for Mechanical Trades
  - 2. Section 23 05 13 - Common Motor Requirements for HVAC Equipment: Product requirements for motors for placement by this section.
  - 3. Division 26 - Equipment Wiring Connections: Execution requirements for electric connection to units specified by this section.

#### 1.2 REFERENCES

- A. NEMA - National Electrical Manufacturers Association:
  - 1. NEMA MG 1 - Motors and Generators.
- B. UL - Underwriters Laboratories Inc.

#### 1.3 SUBMITTALS

- A. Division 1 - Submittal Procedures: Submittal procedures.
- B. Shop Drawings: Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations. Indicate schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers.
- C. Product Data: Submit coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions. Submit mechanical and electrical service locations, capacities and accessories or optional items.
- D. Manufacturer's Installation Instructions: Submit assembly, support details, and connection requirements.
- E. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

#### 1.4 CLOSEOUT SUBMITTALS

- A. Division 1 - Execution and Closeout Requirements: Closeout procedures.
- B. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access.

- C. Operation and Maintenance Data: Submit manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.
- B. Installer: Company specializing in performing Work of this section with minimum three years documented experience.

#### 1.6 PRE-INSTALLATION MEETINGS

- A. Division 1 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Division 1 - Product Requirements: Product storage and handling requirements.
- B. Accept units on site in factory packing. Inspect for damage. Store under roof.
- C. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors. Protect coils from entry of dirt and debris with pipe caps or plugs.

#### 1.8 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.

#### 1.9 WARRANTY

- A. Division 1 - Execution and Closeout Requirements: Product warranties and product bonds.

### PART 2 PRODUCTS

#### 2.1 ELECTRIC BASEBOARD RADIATION

- A. Manufacturers:
  - 1. Berko.
  - 2. Q Mark
  - 3. Marley
- B. Heating Elements: Heating element wires shall consist of 80% nickel, 20% chromium, and shall be encased in steel sheath with aluminum fins.
- C. Enclosures: Minimum 0.024 inch thick painted steel with minimum .035 inch steel control boxes.



- D. Finish shall be textured polyester powder coating.
- E. Baseboard and accessories shall be UL listed or ETL Listed.
- F. Accessories:
  - 1. Disconnect switch.
  - 2. Remote mounted single pole thermostat rated at 22 amps at 120V – 277V.

## 2.2 ELECTRIC CABINET UNIT HEATERS

- A. Manufacturers:
  - 1. Berko.
  - 2. Q Mark
  - 3. Marley
- B. Heating Elements: Heating Element wires shall consist of 80% nickel, 20% chromium, and shall be encased in steel sheath with aluminum fins.
- C. Enclosures: Galvanized steel frame and back box with 14 gauge front cover; powder coated.
- D. Heater and accessories shall be UL listed or ETL Listed with manual reset thermal overheat protection.
- E. Fans: Aluminum blades, direct-drive, centrifugal, statically and dynamically balanced. Fan shall be served by TEFC motor.
- F. Provide with:
  - 1. Disconnect switch.
  - 2. Integral adjustable thermostat dial.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Division 1 - Administrative Requirements: Coordination and project conditions.
- B. For recessed units, verify recess dimensions are correct size.
- C. Verify wall construction is ready for installation.
- D. Verify concealed blocking and supports are in place and connections are correctly located.

### 3.2 INSTALLATION

- A. Provide supports for equipment including bracing to walls.
- B. Protect coils to prevent damage to fins and flanges. Comb out bent fins.

- C. Install equipment exposed to finished areas after walls and ceilings are finished and painted. Avoid damage.
- D. Protection: Install finished cabinet units with protective covers during remainder of construction.

### 3.3 CLEANING

- A. Division 1 - Execution and Closeout Requirements: Final cleaning.
- B. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- C. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION 238208

SECTION 260400 GENERAL CONDITIONS FOR ELECTRICAL TRADES

PART 1 GENERAL

1.1 RELATED REQUIREMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. This section applies to certain sections of Division 08 “Openings”, Division 11 “Equipment”, Division 12 “Furnishings”, Division 21 “Fire Protection”, Division 22 “Plumbing”, Division 23 "Mechanical," Division 27 “Communications”, Division 28 “Electronic safety and Security”, Division 33 “Utilities” and this section applies to all sections of Division 26, "Electrical" of this project specification unless specified otherwise in the individual sections.
- C. The Drawings of other trades Architectural, Structural, Landscape, Civil, Mechanical, Fire Protection and Plumbing, Communications, and Electronic Safety and Security shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.
- D. The drawings of equipment suppliers shall be examined for coordination and familiarity of work with Owner’s equipment suppliers.
- E. Section 019113 – General Commissioning Requirements and related specification sections apply.
- F. Section 017419 - Construction and Demolition Waste Management and Disposal.
- G. Section 018113 - Sustainable Design Requirements.
- H. Section 018119 - Construction Indoor Air Quality Requirements.

1.2 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project’s environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut’s High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project’s target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project’s sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project’s sustainability goals and LEED certification

- B. LEED v4 Submittals: For all interior, wet-applied adhesives, sealants, paints and coatings related to the work of this Section, submit product and material documentation as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

### 1.3 DESCRIPTION

- A. The General Conditions and Supplementary General Conditions are a part of this Division and are to be considered a part of this Contract.
- B. Where items of the General Conditions and Supplementary General Conditions are repeated in other Sections of the Specifications, it is merely intended to qualify or to call particular attention to them. It is not intended that any other parts of the General Conditions and Supplementary General Conditions shall be assumed to be omitted if not repeated therein. This Section applies equally and specifically to all Contractors supplying labor and/or equipment and/or materials as required under each Section of this Division, Division 27 and Division 28. Where conflicts exist between the drawings and the specifications or between this section of the specifications and other sections, the more stringent or higher cost option shall apply.
- C. It is the intent of this Section of the Specifications to establish a standard of quality and performance characteristics for basic materials and installation methods used in building electrical (communications and electronic safety and security) systems.

### 1.4 INTENT

- A. This contract is for all labor, materials and equipment required for installation. The system shall be complete and finished in all respects, tested and ready for operation. Work shall include calibration of equipment with factory settings. All materials, equipment and apparatus shall be new and of first class quality.
- B. Any apparatus, appliance, material or work not shown on drawings but mentioned in the specifications, or vice versa, or any incidental accessories necessary to make the work complete and perfect in all respects and ready for operation as determined by good trade practice even if not particularly specified, shall be furnished, delivered and installed under their respective Divisions without any additional expense to the Owner.
- C. Minor details not usually shown or specified but necessary for proper installation and operation shall be included in the work as though they were hereinafter shown or specified.
- D. Work under each Section shall include giving written notice to the Owner and Engineer of any materials or apparatus believed inadequate or unsuitable; in violation of laws, ordinances, rules or regulations of authorities having jurisdiction; and any necessary items of work omitted. In the absence of such written notice, it is mutually agreed that work under each Section has included the cost of all required items for the accepted, satisfactory functioning of the entire system without extra compensation.

- E. Location of all existing systems and equipment shown on floor plans is based on the best available information. The Contractor shall verify all dimensions and locations of existing systems and equipment in the field and adjust as necessary.
- F. Certain items of existing equipment may be indicated for removal or relocation. Items noted for removal shall be disconnected and turned over to the Owner or disposed of by the Contractor if the Owner so requests. If instructed to dispose of items, the Contractor shall remove the items from the premises and dispose of them in a safe, legal and responsible manner and location. Items noted for relocation are intended for reuse in another location as designated on the Drawings. It shall be the responsibility of the Contractor to remove the material from its present location, store the material in a safe place and reinstall the material in its new location. Questions regarding the suitability of the material or equipment shall be brought to the attention of the Owner and Engineer in writing.
- G. Wherever a particular piece of equipment, device or material is specifically indicated on the Drawings by model number, type, series or other means, that specification shall take precedence over equipment or materials specified herein. For example: If a particular switch is specified on the Drawings, its specification takes precedence over switch specified herein.

#### 1.5 DEFINITIONS

- A. Word “Subcontractor” means specifically the subcontractor working under this Division. Other Contractors are specifically designated “Plumbing Subcontractor”, “General Contractor” and so on. Note: Take care to ascertain limits of responsibility for connecting equipment which requires connections by two or more trades.
- B. Word “install” shall mean set in place complete with all mounting facilities and connections as necessary ready for normal use or service.
- C. Words “furnish” or “supply” shall mean purchase, deliver to, and off-load at the job site, all ready to be installed including where appropriate all necessary interim storage and protection.
- D. Word “provide” shall mean furnish (or supply) and install as necessary.
- E. Word “finished” refers to all rooms and areas scheduled to be painted in Room Finish Schedule on the drawings. All rooms and areas not covered in Schedule, including underground tunnels and areas above ceilings shall be considered not finished, unless otherwise noted.
- F. No Exceptions Taken – reviewed and determined to be in general conformance with contract documents.
- G. Words “approved equal” mean any product which in the opinion of the Engineer is equal in quality, arrangement, appearance, and performance to the product specified.

- H. Word “wiring” shall mean cable assembly, raceway, conductors, fittings and any other necessary accessories to make a complete wiring system.
- I. Word “product” shall mean any item of equipment, material, fixture, apparatus, appliance or accessory installed under this Division.
- J. Substitutions: Requests for changes in products, materials, equipment, and methods of construction required by Contract Documents proposed by the Contractor after award of the Contract are considered requests for "substitutions."
- K. Indicated: The term "indicated" refers to graphic representations, notes, or schedules on the Drawings, other paragraphs or schedules in the Specifications, and similar requirements in the Contract Documents. Where terms such as "shown," "noted," "scheduled," and "specified" are used, it is to help the reader locate the reference; no limitation on location is intended.
- L. Directed: Terms such as "directed," "requested," "authorized," "selected," "approved," "required," and "permitted" mean "directed by the Engineer," "requested by the Engineer," and similar phrases.
- M. Approve: The term "approved," where used in conjunction with the Engineer's action on the Contractor's submittals, applications, and requests, is limited to the Engineer's duties and responsibilities as stated in General and Supplementary Conditions.
- N. Regulation: The term "Regulations" includes laws, ordinances, statutes, and lawful orders issued by authorities having jurisdiction, as well as rules, conventions, and agreements within the construction industry that control performance of the Work.
- O. Remove: The term “remove” means “to disconnect from its present position, remove from the premises and to dispose of in a legal manner.”
- P. Standard Product Warranties are preprinted written warranties published by individual manufacturers for particular products and are specifically endorsed by the manufacturer to the Owner.
- Q. Special Warranties are written warranties required by or incorporated in the Contract Documents, either to extend time limits provided by standard warranties or to provide greater rights for the Owner.

## 1.6 DRAWINGS

- A. Drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Consult the Architectural Drawings and Details for exact location of fixtures and equipment; where same are not definitely located, obtain this information from the Architect. (Do not scale the drawings)
- B. Work under each Section shall closely follow Drawings in layout of work; check Drawings of other Divisions to verify spaces in which work will be installed. Maintain

maximum headroom; where space conditions appear inadequate, Owner and Engineer shall be notified before proceeding with installations.

- C. The Owner may, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades and/or for proper execution of the work.
- D. Where variances occur between the Drawings and Specifications or within either of the Documents, the item or arrangement of better quality, higher rating, or higher value shall be included in the Contract price. The Owner and Engineer shall decide on the item and the manner in which the work shall be installed.

#### 1.7 SURVEYS AND MEASUREMENTS

- A. Before submitting his Bid, the Contractors shall visit the site and become thoroughly familiar with all existing conditions under which his work will be installed. This Contract includes all modifications of existing systems required for the installation of new equipment. This Contract includes all necessary offsets, transitions and modifications required to install all new equipment in existing spaces. All new and existing equipment and systems shall be fully operational under this Contract before the job is considered complete. The Contractors shall be held responsible for any assumptions he makes, any omissions or errors he makes as a result of his failure to become fully familiar with the existing conditions at the site and the Contract Documents.
- B. The Contractor shall base all measurements, both horizontal and vertical, from established bench marks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.
- C. Should the Contractor discover any discrepancies between actual measurements and those indicated which prevent following good practice or which interfere with the intent of the Drawings and Specifications, the Engineer will be notified and work will not proceed until instructions from the Engineer are received.

#### 1.8 CODES AND STANDARDS

- A. Reference Standard Compliance
  - 1. Where equipment or materials are specified to conform to industry and technical society reference standards of the organizations such as American National Standards Institute (ANSI), American Society for Testing and Materials (ASTM), National Electrical Manufacturers Association (NEMA), and Underwriters Laboratories Inc. (UL), submit proof of such compliance. The label or listing by the specified organization will be acceptable evidence of compliance.
  - 2. Independent Testing Organization Certificate: In lieu of the label or listing, indicated above submit a certificate from an independent testing organization, competent to perform testing, and approved by the engineer. The certificate shall state that the item has been tested in accordance with the specified organization's

test methods and that the item complies with the specified organization's reference standard.

- B. The Following Codes and Standards for the state and local jurisdiction where the project is located as listed below apply to all electrical work. Wherever Codes and/or Standards are mentioned in these Specifications, the latest applicable edition or revision shall be followed:

Connecticut State Building Code Including all Supplements  
Connecticut State Fire Safety Code Including all Supplements  
Building Standards Guidelines – Compliance for High Performance Buildings  
The International Building Code  
The International Mechanical Code  
The International Plumbing Code  
NFPA 70, the National Electrical Code  
Model Energy Code  
NECA - 1 Standard for Good Workmanship in Electrical Construction  
ASHRAE 90.1 and International Energy Conservation Code

- C. The following Standards shall be used where referenced by the following abbreviations:

AIA	American Institute of Architects
ANSI	American National Standards Institute
ASME	American Society of Mechanical Engineers
ASTM	American Society of Testing and Materials
EPA	Environmental Protection Agency
FM	Factory Mutual
FSSC	Federal Specification
IEEE	Institute of Electrical and Electronics Engineers
NBS	National Bureau of Standards
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NSC	National Safety Council
OSHA	Occupational Safety and Health Administration
UL	Underwriters' Laboratories

- D. All materials furnished and all work installed shall comply with the rules and recommendations of the NFPA, the requirements of the local utility companies, the recommendations of the fire insurance rating organization having jurisdiction and the requirements of all Governmental departments having jurisdiction.
- E. The Contractor shall include in the work, without extra cost to the Owner, any labor, materials, services, apparatus and Drawings in order to comply with all applicable laws, ordinances, rules and regulations, whether shown on Drawings and/or specified or not.

## 1.9 PERMITS AND FEES

- A. The Contractor shall give all necessary notices, obtain all permits; and pay all Government and State sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the work, file all necessary



Drawings, prepare all documents and obtain all necessary approvals of all Governmental and State departments having jurisdiction, obtain all required certificates of inspection for his work, and deliver a copy to the Owner and Engineer before request for acceptance and final payment for the work.

#### 1.10 EQUIPMENT EQUIVALENTS AND SUBSTITUTIONS

- A. Certain manufacturers of material, apparatus or appliances are indicated in the drawings and specifications for this project. These items have been used as the basis of design, and as a convenience in fixing the minimum standard of workmanship, finish and design that is required. If the Contractor uses an “approved equal” alternative to the basis of design, and if the features of that alternative have an impact on other components of the Project, the Contractor shall include the necessary adjustments in those components, whether for architectural, structural, mechanical, electrical, fire protection, or any other elements, plus any adjustments for difference in performance.
- B. Where one name only is used and is followed by the words “or approved equal”, the Contractor must use the item named or he is required to apply for a substitution. Where one name only is used, the Contractor must use that item named.
- C. Where no specific make of material, apparatus or appliance is mentioned, any first-class product made by a reputable manufacturer may be submitted for Architect and Engineer review.
- D. Where the Contractor proposes to use an item that is different from the basis of design in the Drawings and specifications, and that will require the redesign of the structure, partitions, foundations, piping, wiring or any other component of the mechanical, electrical, or architectural layout, the Contractor shall provide the necessary redesign of those components.
- E. Where the Contractor proposes to deviate (provide an equivalent or request for substitution) from the basis of design scheduled equipment or materials as hereinafter specified or shown on the drawings, they are required to submit a requested for substitution in writing. The Contractor shall state in their request whether it is a substitution, equivalent or a non approved equivalent to that specified and the amount of credit or extra cost involved. A copy of said request shall be included in the Base Bid with manufacturer’s equipment cuts. The Base Bid shall be based on using the materials and equipment as specified with no exceptions.
- F. If an alternative or substitute item results in a difference in quantity and arrangement of piping, ductwork, valves, pumps, insulation, wiring, conduit, and equipment from that specified or indicated on the Drawings, the Contractor shall furnish and install any such additional equipment required by the system, at no additional cost to the Owner including any costs added to other trades due to the equivalent change from the basis of design detailed in the drawings or included within the specifications.

- G. Equipment, material or devices submitted for review as an “equivalent” shall meet the following requirements:
1. The equivalent shall have the same construction features such as, but not limited to:
    - a. Material thickness, gauge, weight, density, etc.
    - b. Welded, riveted, bolted, etc., construction
    - c. Finish, undercoating, corrosion protection
  2. The equivalent shall perform with the same or better operating efficiency.
  3. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  4. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL or NEMA labels.
- H. Equipment, material or devices submitted for review as a “substitution” shall meet the following requirements:
1. Substitution Request Submittal: Requests for substitution will be considered if received in writing 14 days before the bid date. Requests received later than 14 days before the bid date may be considered or rejected at the discretion of the Engineer/Owner. Once the Contractor submits a complete request for substitution as determined by the engineer, the engineer reserves the right to request the time necessary to evaluate the request for substitution and review it with the Owner.
  2. Submit three (3) copies of each request for substitution for consideration.
  3. Identify the product, or the fabrication or installation method to be replaced in each request. Include related Specification Section and Drawing numbers. Provide complete documentation showing compliance with the requirements for substitutions, and the following information, as appropriate:
    - a. Product Data, including Drawings and descriptions of products, fabrication and installation procedures.
    - b. Samples, where applicable or requested.
    - c. A detailed comparison of significant qualities of the proposed substitution with those of the Work specified. Significant qualities may include elements such as size, weight, durability, performance and visual effect.
    - d. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by the Owner and separate Contractors that will become necessary to accommodate the proposed substitution.
    - e. A statement indicating the substitution's effect on the Contractor's Construction Schedule compared to the schedule without approval of the substitution. Indicate the effect of the proposed substitution on overall Contract Time.
    - f. Cost information, including a proposal of the net change, if any in the Contract Sum.
    - g. Certification by the Contractor that the substitution proposed is equal-to or better in every significant respect to that required by the Contract Documents, and that it will perform adequately in the application indicated. Include the Contractor's waiver of rights to additional payment

- or time that may subsequently become necessary because of the failure of the substitution to perform adequately.
- h. Engineer's Action: Within one week of receipt of the request for substitution, the Engineer will notify the Contractor of acceptance or rejection of the proposed substitution. If a decision on use of a proposed substitute cannot be made or obtained within the time allocated, use the product specified by name. Acceptance of a product substitution will be in the form of an Addendum.
  - i. Other Conditions: The Contractor's substitution request will be received and considered by the Engineer when one or more of the following conditions are satisfied, as determined by the Engineer; otherwise requests will be returned without action except to record noncompliance with these requirements.
    - 1) The request is directly related to an "or equal" clause or similar language in the Contract Documents.
    - 2) The specified product or method of construction cannot be provided within the Contract Time. The request will not be considered if the product or method cannot be provided as a result of failure to pursue the Work promptly or coordinate activities properly.
    - 3) A substantial advantage is offered the Owner, in terms of cost, time, energy conservation or other considerations of merit, after deducting offsetting responsibilities the Owner may be required to bear. Additional responsibilities for the Owner may include additional compensation to the Engineer for redesign and evaluation services, increased cost of other construction by the Owner or separate Contractors, and similar considerations.

#### 1.11 SUBMITTAL PROCEDURES

- A. Provide Submittals in accordance with the requirements of Division 1 and as indicated in the following.
- B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Transmit each submittal sufficiently in advance of performance of related construction activities to avoid delay.
  - 1. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals and related activities that require sequential activity.
  - 2. Coordinate transmittal of different types of submittals for related elements of the Work so processing will not be delayed by the need to review submittals concurrently for coordination. The Engineer reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

- C. Processing: Allow sufficient review time so that installation will not be delayed as a result of the time required to process submittals, including time for resubmittals.
1. Allow two weeks for initial review. Allow additional time if processing must be delayed to permit coordination with subsequent submittals. The Engineer will promptly advise the Contractor when a submittal being processed must be delayed for coordination.
  2. If an intermediate submittal is necessary, process the same as the initial submittal.
  3. Allow two weeks for reprocessing each submittal.
  4. No extension of Contract Time will be authorized because of failure to transmit submittals to the Engineer sufficiently in advance of the Work to permit processing.
- D. Submittal Preparation: Place a permanent label or title block on each submittal for identification. Indicate the name of the entity that prepared each submittal on the label or title block.
1. Include the following information on the label for processing and recording action taken.
    - a. Project name.
    - b. Date.
    - c. Name and address of Engineer.
    - d. Name and address of Contractor.
    - e. Name and address of subcontractor.
    - f. Name and address of supplier.
    - g. Name of manufacturer.
    - h. Number and title of appropriate Specification Section.
    - i. Drawing number and detail references, as appropriate.
- E. Submittal Transmittal: Package each submittal appropriately for transmittal and handling. Transmit each submittal from Contractor to Engineer using a transmittal form. Submittals received from sources other than the Contractor will be returned without action. On the transmittal, record relevant information and requests for data. On the form, or separate sheet, record deviations from Contract Document requirements, including minor variations and limitations. Include Contractor's certification that information complies with Contract Document requirements.
- F. Except for submittals for record, information or similar purposes, where action and return is required or requested, the Engineer will review each submittal, mark to indicate action taken, and return promptly. Compliance with specified characteristics is the Contractor's responsibility.
- G. Action Stamp: The Engineer will stamp each submittal with a uniform, self-explanatory action stamp. The stamp will be appropriately marked, to indicate the action taken.

#### 1.12 SHOP DRAWINGS

- A. Submit newly prepared information, drawn to accurate scale. Highlight, encircle, or otherwise indicate deviations from the Contract Documents. Do not reproduce Contract

Documents or copy standard information as the basis of Shop Drawings. Standard information prepared without specific reference to the Project is not considered Shop Drawings.

- B. The Contractor shall submit for review detailed shop drawings of all equipment and material specified in each section and coordinated ductwork layouts. No material or equipment may be delivered to the job site or installed until the Contractor has received shop drawings for the particular material or equipment which have been properly reviewed. Shop drawings shall be submitted within 60 days after award of Contract before any material or equipment is purchased. The Contractor shall submit for review copies of all shop drawings to be incorporated in the Electrical Contract. Refer to the General Conditions and Supplementary General Conditions for the quantity of copies required for submission. Where quantities are not specified, provide seven (7) copies for review.
- C. Provide shop drawings for all devices specified under equipment specifications for all systems including fire alarm, switchgear, clock, lighting, etc., or where called for elsewhere in the Specifications, or where scheduled on the drawings, or where called out on the drawings. Shop drawings shall include manufacturers' names, catalog numbers, cuts, diagrams, dimensions, identification of products and materials included, compliance with specified standards, notation of coordination requirements, notation of dimensions established by field measurement and other such descriptive data as may be required to identify and accept the equipment. A complete list in each category (example: all fixtures) of all shop drawings, catalog cuts, material lists, etc., shall be submitted to the Engineer at one time. No consideration will be given to a partial shop drawing submittal.
- D. Submittals shall be marked with the trade involved, i.e., Electrical, HVAC, Plumbing, Fire Protection, etc. when the submittal could involve more than one trade.
- E. Where multiple quantities or types of equipment are being submitted, provide a cover sheet (with a list of contents) on the submittal identifying the equipment or material being submitted.
- F. Failure to submit shop drawings in ample time for review shall not entitle the Contractor to an extension of Contract time. No claim for extension by reason of such default will be allowed, nor shall the Contractor be entitled to purchase, furnish and/or install equipment which has not been reviewed by the Engineer.
- G. The Contractor shall furnish all necessary templates, patterns, etc., for installation work and for the purpose of making adjoining work conform; furnish setting plans and shop details to other trades as required.
- H. Acceptance rendered on shop drawings shall not be considered as a guarantee of measurements or building conditions. Where drawings are reviewed, review does not mean that drawings have been checked in detail; said approval does not in any way relieve the Contractor from his responsibility or necessity of furnishing material or performing work as required by the Contract Drawings and Specifications. Verify available space prior to submitting shop drawings.

- I. Acceptance of shop drawings shall not apply to quantity nor relieve Contractor of his responsibility to comply with intent of Drawings and Specifications.
- J. Acceptance of shop drawings is final and no further changes will be allowed without the written consent of the Engineer.
- K. Acceptance of shop drawings does not relieve the Contractor from submitting, coordinating and implementing schedules, forms, worksheets and similar as required for owner/operator input and approval as specified herein and required for proper system operation.
- L. Shop drawing submittal sheets which may show items that are not being furnished shall have those items crossed off to clearly indicate which items will be furnished.
- M. Bidders shall not rely on any verbal clarification of the Drawings and/or Specifications. Any questions shall be referred to the Engineer in writing at least five (5) working days prior to Bidding to allow for issuance of an Addendum.
- N. Do not use Shop Drawings without an appropriate final stamp indicating action taken in connection with construction.

#### 1.13 COORDINATION DRAWINGS

- A. Prepare coordination drawings in accordance with Division 01 Section "PROJECT COORDINATION," to a scale of 1/4"=1'-0" or larger; detailing major elements, components, and systems of electrical equipment and materials in relationship with other systems, installations, and building components. Indicate locations where space is limited for installation and access and where sequencing and coordination of installations are of importance to the efficient flow of the Work, including (but not necessarily limited to) the following:
  - 1. Indicate the proposed locations of light fixtures, panelboards, conduits, cabinets, etc. Include the following:
  - 2. Clearances for installing and maintaining insulation.
  - 3. Clearances for servicing and maintaining equipment, including NEC requirements and space for equipment disassembly required for periodic maintenance.
  - 4. Equipment connections and support details.
  - 5. Exterior wall and foundation penetrations.
  - 6. Fire-rated wall and floor penetrations.
  - 7. Sizes and locations of required concrete pads and bases.
- B. Indicate scheduling, sequencing, movement, and positioning of large equipment into the building during construction.
- C. Prepare floor plans, elevations, and details to indicate penetrations in floors, walls, and ceilings and their relationship to other penetrations and installations.



- D. Prepare reflected ceiling plans to coordinate and integrate installations, air outlets and inlets, light fixtures, communication systems components, sprinklers, and other ceiling-mounted items.
- E. Electronic copies of the MEP floor plans are available to use as a basis for preparing coordination drawings and can be provided by the Engineer. If the Contractor elects to obtain the Engineers electronic files an Electronic File Release Form must be submitted with payment. This form must be signed by the Contractor, Owner, and Architect. Upon receipt of a signed copy of the Electronic File Release Form, and payment, the Engineer will provide copies of the electronic files for the Contractor's use. A copy of the Electronic File Release Form is appended to the end of this specification section

#### 1.14 COORDINATION WITH OTHER DIVISIONS

- A. All work shall be carried out in conjunction with other trades and full cooperation shall be given in order that all work may proceed with a minimum of delay and interference. Particular emphasis is placed on timely installation of major apparatus and furnishing other Contractors, especially the Contractor or Construction Manager, with information as to openings, chases, sleeves, bases, inserts, equipment locations, panels, etc., required by other trades.
- B. The Contractors are required to examine all of the Project Drawings and mutually arrange work so as to avoid interference with the work of other trades. In general, ductwork, heating, condenser, chilled water piping, sprinkler piping and drainage lines take precedence over water, gas and electrical conduits. The Engineer shall make final decisions regarding the arrangement of work which cannot be agreed upon by the Contractors.
- C. Where the work of the Contractor will be installed in close proximity to or will interfere with work of other trades, the Contractors will cooperate in working out space conditions to make a satisfactory adjustment.
- D. If the work under a Section is installed before coordinating with other Divisions or Sections or so as to cause interference with work of other Sections, the necessary changes to correct the condition shall be made by the Contractor causing the interference without extra charge to the Owner.
- E. Where work is installed prior to preparation and approval of the Coordination Drawings or in conflict with the approved Coordination drawings and if so directed in other Sections, the Contractor indicated shall prepare composite working drawings and sections clearly showing how the work is to be installed in relation to the work of other trades, at no extra charge to the Owner.

#### 1.15 WORKMANSHIP

- A. Service Support: The equipment items shall be supported by service organizations which are reasonably convenient to the equipment installation in order to render satisfactory service to the equipment on a regular and emergency basis during the warranty period of the contract.

- B. Modification of References: In each of the publications referred to herein, consider the advisory provisions to be mandatory, as though the word, "shall" had been substituted for "should" wherever it appears.
- C. The Contractor shall furnish the services of an experienced superintendent who shall be constantly in charge of the installation of the work together with all skilled workmen, journeymen, electricians, helpers and laborers required to unload, transfer, erect, connect, adjust, start, operate and test each system.
- D. Unless otherwise specifically indicated on the Drawings or Specifications, all equipment and materials shall be installed with the acceptance of the Engineer and in accordance with the recommendations of the manufacturer. This includes the performance of such tests as the manufacturer recommends.
- E. All labor for installation of electrical systems shall be performed by experienced, skilled tradesmen under the supervision of a licensed journeyman foreman. All work shall be of a quality consistent with good trade practice and shall be installed in a neat, workmanlike manner. The Engineer reserves the right to reject any work which, in his opinion, has been installed in a substandard, dangerous or unserviceable manner. The Contractor shall replace said work in a satisfactory manner at no extra cost to the Owner.

#### 1.16 SHUTDOWNS

- A. When installation of a new system requires the temporary shutdown of an existing operating system, the connection of the new system shall be performed at such time as designated by the Owner.
- B. The Engineer and the Owner shall be notified in writing of the estimated duration of the shutdown period at least ten (10) days in advance of the date the work is to be performed.
- C. Work shall be arranged for continuous performance whenever possible. The Contractor shall provide all necessary labor, including overtime if required, to assure that existing operating services will be shut down only during the time actually required to make necessary connections.

#### 1.17 TEMPORARY UTILITIES

- A. General: Provide new materials and equipment; if acceptable to the Engineer, undamaged previously used materials in serviceable condition may be used. Provide materials suitable for the use intended.
- B. Conditions of Use: Keep temporary services and facilities clean and neat in appearance. Operate in a safe and efficient manner. Take necessary fire prevention measures. Do not overload facilities, or permit them to interfere with progress. Do not allow hazardous dangerous or unsanitary conditions, or public nuisances to develop or persist on the site.
- C. First Aid Supplies: Comply with governing regulations.



- D. Fire Extinguishers: Provide hand-carried, portable UL-rated, class "A" fire extinguishers for temporary offices and similar spaces. In other locations provide hand-carried, portable, UL-rated, class "ABC" dry chemical extinguishers, or a combination of extinguishers of NFPA recommended classes for the exposures.
  
- E. Provide temporary lighting in all areas, throughout construction activities.
  - 1. Use Charges: Cost or use charges for temporary facilities are not chargeable to the Owner or Engineer, and will not be accepted as a basis of claims for a Change Order.
  - 2. Temporary Electric Power Service: Provide weatherproof, grounded electric power service and distribution system of sufficient size, capacity, and power characteristics during construction period. Include meters, transformers, overload protected disconnects, automatic ground-fault interrupters, and main distribution switch gear.
    - a. Except where overhead service must be used, install electric power service underground.
    - b. Power Distribution System: Install wiring overhead, and rise vertically where least exposed to damage. Where permitted, wiring circuits not exceeding 125 Volts, AC 20 ampere rating, and lighting circuits may be nonmetallic sheathed cable where overhead and exposed for surveillance.
  - 3. Temporary Telephones: Provide temporary telephone service for all personnel engaged in construction activities, throughout the construction period.
  
- F. Environmental Protection: Provide protection, operate temporary facilities and conduct construction in ways and by methods that comply with environmental regulations, and minimize the possibility that air, waterways and subsoil might be contaminated or polluted, or that other undesirable effects might result. Avoid use of tools and equipment which produce harmful noise. Restrict use of noise making tools and equipment to hours that will minimize complaints from persons or firms near the site.
  
- G. Termination and Removal: Unless the Engineer requires that it be maintained longer, remove each temporary facility when the need has ended, or when replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with the temporary facility. Repair damaged Work, clean exposed surfaces and replace construction that cannot be satisfactorily repaired. Materials and facilities that constitute temporary facilities are property of the Contractor. The Owner reserves the right to take possession of Project identification signs.

#### 1.18 PROJECT PHASING

- A. Work under each Section shall include all necessary temporary connections, equipment, conduit, wiring, fire alarm equipment and testing, lighting and emergency lighting, fire stopping, connection of necessary mechanical equipment, labor, and material as necessary to accommodate the phasing of Construction as developed by the General Contractor or Construction Manager and approved by the Owner. All existing systems that pass-thru an area of the building or are required to be maintained in a phased fashion during construction shall remain operational during all phases of construction. No extra

compensation shall be granted the Contractor for work required to maintain existing systems operational or to accommodate the construction phasing of the project.

#### 1.19 PROTECTION OF MATERIALS AND EQUIPMENT

- A. Work under each Section shall include protecting the work and material of all other Sections from damage by work or workmen and shall include making good all damage thus caused.
- B. The Contractor shall be responsible for work and equipment until the facility has been accepted by the Owner. Protect work against theft, injury or damage and carefully store material and equipment received on site which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of foreign material.
- C. Work under each Section includes receiving, unloading, uncrating, storing, protecting, setting in place and completely connecting equipment supplied under each Section. Work under each Section shall also include exercising special care in handling and protecting equipment and fixtures, and shall include the cost of replacing any of the equipment and fixtures which are missing or damaged.
- D. Equipment and material stored on the job site shall be protected from the weather, vehicles, dirt and/or damage by workmen or machinery. Insure that all electrical or absorbent equipment or material is protected from moisture during storage.

#### 1.20 ADJUSTING AND TESTING

- A. After all the equipment and accessories to be furnished are in place, they shall be put in final adjustment and subjected to such operating tests so as to assure the Engineer that they are in proper adjustment and in satisfactory, permanent operating condition.
- B. Where requested by the Engineer or specified in the contract documents, a factory-trained service representative shall inspect the installation and assist in the initial startup and adjustment to the equipment. The period of these services shall be for such time as necessary to secure proper installation and adjustments. After the equipment is placed in permanent operation, the service representative shall supervise the initial operation of the equipment and instruct the personnel responsible for operation and maintenance of the equipment. The service representative shall notify the Contractor in writing that the equipment was installed according to manufacturer's recommendations and is operating as intended by the manufacturer. Factory start-up reports shall be included in the operation and maintenance manuals under the appropriate equipment section.

#### 1.21 CLEANING

- A. The Contractor shall thoroughly clean all equipment of all foreign substances, oils, dust, dirt, etc., inside and out before final acceptance by the Engineer.
- B. If any part of a system should be stopped or damaged by any foreign matter after being placed in operation, the system shall be disconnected, cleaned and reconnected wherever

necessary to locate and/or remove obstructions. Any work damaged in the course of removing obstructions shall be repaired or replaced when the system is reconnected at no additional cost to the Owner.

- C. During the course of construction, all conduits shall be capped in an acceptable manner to insure adequate protection against the entrance of foreign matter.
- D. Upon completion of all work under the Contract, the Contractor shall remove from the premises all rubbish, debris and excess materials left over from his work.
- E. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion.
  - 1. Remove labels that are not permanent labels.
  - 2. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compound and other substances that are noticeable vision-obscuring materials. Replace chipped or broken glass and other damaged transparent materials.
  - 3. Clean exposed exterior and interior hard-surfaced finishes to a dust-free condition, free of stains, films and similar foreign substances. Restore reflective surfaces to their original reflective condition. Leave concrete floors broom clean. Vacuum carpeted surfaces and panelboard interiors.
  - 4. Wipe surfaces of mechanical and electrical equipment. Remove excess lubrication and other substances. Clean light fixtures and lamps.
- F. Comply with regulations of authorities having jurisdiction and safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on the Owner's property. Do not discharge volatile, harmful or dangerous materials into drainage systems. Remove and dispose of ALL waste materials, packaging material, skids etc. from the site and dispose of in a lawful manner in accordance with municipal, state and federal regulations.
- G. Where extra materials of value remaining after completion of associated Work have become the Owner's property, arrange for disposition of these materials as directed.

## 1.22 OPERATING AND MAINTENANCE

- A. Upon completion of all work and tests, the Contractor shall furnish the necessary skilled labor and helpers for operating his system and equipment for a period specified under each applicable Section of this Division. During this period, he shall fully instruct the Owner or the Owner's representative in the operation, adjustment and maintenance of all equipment furnished. The Contractor shall give at least seven (7) day notice to the Owner and the Engineer in advance of this period.
- B. The Contractor shall include the maintenance schedule for the principal items of equipment furnished under this Division.
- C. The Contractor shall physically demonstrate procedures for all routine maintenance of all equipment furnished under each respective Section to assure accessibility to all devices.

- D. An authorized manufacturer's representative shall attest in writing that the equipment has been properly installed prior to startup of any major equipment. At a minimum, the following equipment will require this inspection: emergency generator, fire alarm system, nurse call system, paging systems, etc. These letters will be bound into the operating and maintenance books.
- E. Refer to individual trade Sections for any other particular requirements related to operating instructions.
- F. Demonstration shall be recorded on CD Rom with two (2) discs turned over to the Owner.

### 1.23 OPERATING AND MAINTENANCE MANUALS

- A. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty, 3-ring, vinyl-covered binders, with pocket folders for folded sheet information. Mark appropriate identification on front and spine of each binder.
- B. Manual shall include the following:
  - 1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  - 2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  - 3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  - 4. Servicing instructions and lubrication charts and schedules.
  - 5. Emergency instructions.
  - 6. Spare parts list.
  - 7. Copies of warranties.
  - 8. Wiring diagrams.
  - 9. Recommended "turn around" cycles.
  - 10. Inspection procedures.
  - 11. Shop Drawings and Product Data.
  - 12. Equipment start-up reports.
- C. Include in the manual, a tabulated equipment schedule for all equipment. Schedule shall include pertinent data such as: make, model number, serial number, voltage, normal operating current, belt size, filter quantities and sizes, bearing number, etc. Schedule shall include maintenance to be done and frequency.

- D. Maintenance and instruction manuals shall be submitted to the Owner at the same time as the seven (7) day notice is given prior to the instruction period.

#### 1.24 ACCEPTANCES

- A. The equipment, materials, workmanship, design and arrangement of all work installed under the Electrical Sections shall be subject to the review of the Engineer.
- B. Within 30 days after the awarding of a Contract, the Electrical Contractor shall submit to the Engineer, for review, a list of manufacturers of equipment proposed for the work under the Electrical Sections. The intent to use the exact makes specified does not relieve the Contractor of the responsibility of submitting such a list.
- C. If extensive or unacceptable delivery time is expected on a particular item of equipment specified, the Contractor shall notify the Owner and Engineer, in writing, within 30 days of the awarding of the Contract. In such instances, deviations may be made pending acceptance by the Engineer or the Owner's representative.
- D. Where any specific material, process or method of construction or manufactured article is specified by reference to the catalog number of a manufacturer, the Specifications are to be used as a guide and are not intended to take precedence over the basic duty and performance specified or noted on the Drawings. In all cases, the Electrical Contractor shall verify the duty specified with the specific characteristics of the equipment offered for review. Equipment characteristics are to be used as mandatory requirements where the Contractor proposes to use an acceptable equivalent.
- E. If material or equipment is installed before it is reviewed and/or approved, the Contractor shall be liable for its removal and replacement at no extra charge to the Owner if, in the opinion of the Engineer, the material or equipment does not meet the intent of, or standard of quality implied by, the Drawings and Specifications.
- F. Failure on the part of the Engineer to reject shop drawings or to reject work in progress shall not be interpreted as acceptance of work not in conformance with the Drawings and/or Specifications. Work not in conformance with the Drawings and/or Specifications shall be corrected whenever it is discovered.

#### 1.25 RECORD DRAWINGS

- A. General: Do not use record documents for construction purposes; protect from deterioration and loss in a secure, fire-resistive location; provide access to record documents for the Engineer's reference during normal working hours.
- B. Record Drawings: Maintain a clean, undamaged set of blue or black line white-prints of Contract Drawings and Shop Drawings. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately; where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.

1. Mark record sets with red erasable pencil; use other colors to distinguish between variations in separate categories of the Work.
2. Mark new information that is important to the Owner, but was not shown on Contract Drawings or Shop Drawings.
3. Note related Change Order numbers where applicable.
4. Organize record drawing sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates and other identification on the cover of each set.
5. Final record documents shall be prepared in the latest AutoCad version and digital media for all drawings and a clean set of reproducible paper copies shall be turned over to the Owner at the completion of the work.

#### 1.26 WARRANTIES AND BONDS

- A. The following general administrative and procedural requirements for warranties and bonds required by the Contract Documents, including manufacturers standard warranties on products and special warranties are to be included:
  1. General close-out requirements included in Section "Project Close-out."
  2. Specific requirements for warranties for the Work and products and installation that are specified to be warranted, are included in the individual Sections of Divisions 02 through [50].
  3. Certifications and other commitments and agreements for continuing services to Owner are specified elsewhere in the Contract Documents.
- B. Disclaimers and Limitations: Manufacturer's disclaimers and limitations on product warranties do not relieve the Contractor of the warranty on the Work that incorporates the products, nor does it relieve suppliers, manufacturers, and subcontractors required to countersign special warranties with the Contractor.
- C. Separate Prime Contracts: Each prime Contractor is responsible for warranties related to its own Contract.

#### 1.27 WARRANTY REQUIREMENTS

- A. Related Damages and Losses: When correcting warranted Work that has failed, remove and replace other Work that has been damaged as a result of such failure or that must be removed and replaced to provide access for correction of warranted Work.
- B. Reinstatement of Warranty: When Work covered by a warranty has failed and been corrected by replacement or rebuilding, reinstate the warranty by written endorsement. The reinstated warranty shall be equal to the original warranty with an equitable adjustment for depreciation.
- C. Replacement Cost: Upon determination that Work covered by a warranty has failed, replace or rebuild the Work to an acceptable condition complying with requirements of Contract Documents. The Contractor is responsible for the cost of replacing or rebuilding defective Work regardless of whether the Owner has benefited from use of the Work through a portion of its anticipated useful service life.



- D. **Owner's Recourse:** Written warranties made to the Owner are in addition to implied warranties, and shall not limit the duties, obligations, right and remedies otherwise available under the law, nor shall warranty periods be interpreted as limitations on time in which the Owner can enforce such other duties, obligations, rights, or remedies.
- E. **Rejection of Warranties:** The Owner reserves the right to reject warranties and to limit selections to products with warranties not in conflict with requirements of the Contract Documents.
- F. The Owner reserves the right to refuse to accept Work for the Project where a special warranty, certification, or similar commitment is required on such Work or part of the Work, until evidence is presented that entities required to countersign such commitments are willing to do so.
- G. Submit written warranties to the Engineer prior to the date certified for Substantial Completion. If the Engineer's Certificate of Substantial Completion designates a commencement date for warranties other than the date of Substantial Completion for the Work, or a designated portion of the Work, submit written warranties upon request of the Engineer.
- H. When a designated portion of the Work is completed and occupied or used by the Owner, by separate agreement with the Contractor during the construction period, submit properly executed warranties to the Engineer within fifteen days of completion of that designated portion of the Work.
- I. When a special warranty is required to be executed by the Contractor, or the Contractor and a subcontractor, supplier or manufacturer, prepare a written document that contains appropriate terms and identification, ready for execution by the required parties. Submit a draft to the Owner through the Engineer for approval prior to final execution.
  - 1. Refer to individual Sections of Divisions 2 through [16][50] for specific content requirements, and particular requirements for submittal of special warranties.
- J. **Form of Submittal:** At Final Completion compile two copies of each required warranty and bond properly executed by the Contractor, or by the Contractor, subcontractor, supplier, or manufacturer. Organize the warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- K. Bind warranties and bonds in heavy-duty, commercial quality, durable 3-ring vinyl covered loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2" by 11" paper.
  - 1. Provide heavy paper dividers with celluloid covered tabs for each separate warranty. Mark the tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product, and the name, address and telephone number of the installer.
  - 2. Identify each binder on the front and the spine with the typed or printed title "WARRANTIES AND BONDS," the Project title or name, and the name of the Contractor.

3. When operating and maintenance manuals are required for warranted construction, provide additional copies of each required warranty, as necessary, for inclusion in each required manual.

#### 1.28 GUARANTEES

- A. The Contractor shall guarantee all material and workmanship under these Specifications and the Contract for a period of one (1) year from the date of final acceptance by Owner. During this guarantee period, all defects developing through faulty equipment, materials or workmanship shall be corrected or replaced immediately by this Contractor without expense to the Owner. Such repairs or replacements shall be made to the Engineers satisfaction.
- B. Contractor shall provide name, address, and phone number of all contractors and subcontractors and associated equipment they provided

#### 1.29 PROJECT CLOSE-OUT

- A. Contractor shall submit annual maintenance proposal to the Architect/Engineer for review and approval as part of the close out documents.
- B. DEEP Equipment Forms: In addition to standard cut sheets for equipment, provide separate listing of all equipment along with tag, description, capacity ratings, model #, Serial #, etc. Forms shall be submitted electronically in spread sheet format
- C. Submit specific warranties, workmanship bonds, maintenance agreements, final certifications and similar documents.
- D. Deliver tools, spare parts, extra stock, and similar items.
- E. Complete start-up testing of systems, and instruction of the Owner's operating and maintenance personnel. Discontinue or change over and remove temporary facilities from the site, along with construction tools, mock-ups, and similar elements.
- F. Complete final clean up requirements, including touch-up painting. Touch-up and otherwise repair and restore marred exposed finishes.
- G. Inspection Procedures: On receipt of a request for inspection, the Engineer will either proceed with inspection or advise the Contractor of unfilled requirements. The Engineer will prepare the Certificate of Substantial Completion following inspection, or advise the Contractor of construction that must be completed or corrected before the certificate will be issued.
  1. The Engineer will repeat inspection when requested and assured that the Work has been substantially completed.
  2. Results of the completed inspection will form the basis of requirements for final acceptance.

END OF SECTION 260400



## Electronic File Release Form

DELIVERY OF ELECTRONIC FILES FOR: \_\_\_\_\_  
Project Name

In accepting and utilizing any drawings or other data on any form of electronic media generated and provided by the Design Professional, the Client covenants and agrees that all such drawings and data are instruments of service of the Design Professional, who shall be deemed the author of the drawings and data, and shall retain all common law, statutory law and other rights, including copyrights.

The Client further agrees not to use these drawings and data, in whole or in part, for any purpose or project other than the project which is the subject of this Agreement. The Client agrees to waive all claims against the Design Professional resulting in any way from any unauthorized changes or reuse of the drawings and data for any other project by anyone other than the Design Professional.

In addition, the Client agrees, to the fullest extent permitted by law, to indemnify and hold the Design Professional harmless from any damage, liability or cost, including reasonable attorneys' fees and costs of defense, arising from any changes made by anyone other than the Design Professional or from any reuse of the drawings and data without the prior written consent of the Design Professional.

Under no circumstances shall transfer of the drawings and other instruments of service on electronic media for use by the Client be deemed a sale by the Design Professional, and the Design Professional makes no warranties, either express or implied, of merchantability and fitness for any particular purpose.

_____ Client's Signature	_____ Date
_____ Company - Title	
_____ Architects' Signature	_____ Date
_____ Firm - Title	
_____ Owner's Signature	_____ Date
_____ Company - Title	

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## SECTION 260503 - EQUIPMENT WIRING CONNECTIONS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes electrical connections to equipment.
- B. Related Sections:
  - 1. Section 26 0519 – Low Voltage Electrical Power Conductors and Cables.
  - 2. Section 26 0533 - Raceway and Boxes for Electrical Systems.
  - 3. Section 26 2726 – Wiring Devices.
  - 4. Section 26 2813 – Fuses.
  - 5. Section 26 2819 - Enclosed Switches.
  - 6. Section 26 2913 – Enclosed Controllers.
- C. Related Requirements:
  - 1. This section applies to certain sections of Division 8 “Door Hardware”, Division 11 “Equipment”, Division 12 “Furnishings”, Division 21 “Fire Protection”, Division 22 “Plumbing”, Division 23, "Mechanical,", Division 27 “Communications”, and Division 28 “Electronic Safety and Security” of this project specification unless specified otherwise in the individual sections.
  - 2. The Drawings of other trades (Architectural, Plumbing, Mechanical, Fire Protection, Communications, and Electronic Safety and Security) shall be examined for coordination and familiarity of work with other Contractors. Any duplication or omission of provisions in this project should be brought to the attention of the Owners prior to Bidding.

#### 1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA WD 1 - General Requirements for Wiring Devices.
  - 2. NEMA WD 6 - Wiring Devices-Dimensional Requirements.

#### 1.3 SUBMITTALS

- A. See Division 01- General Requirements.
- B. Product Data: Submit wiring device manufacturer’s catalog information showing dimensions, configurations, and construction.
- C. Manufacturer's installation instructions.

#### 1.4 CLOSEOUT SUBMITTALS

- A. See Division 01- General Requirements.

- B. Project Record Documents: Record actual locations, sizes, and configurations of equipment connections.

## 1.5 COORDINATION

- A. See Division 01- General Requirements.
- B. Obtain and review equipment schedules and specifications for equipment furnished under other sections.
- C. Obtain and review shop drawings, product data, manufacturer's wiring diagrams, and manufacturer's instructions for equipment furnished under other sections.
- D. Determine connection locations and requirements, including requirements for enclosed switches, enclosed controllers, variable frequency drives, control stations, safety devices, control wiring, and accessories for equipment furnished under other sections.
- E. Sequence rough-in of electrical connections to coordinate with installation of equipment. Do not proceed with rough-in without coordination of requirements for equipment furnished under other sections.
- F. Sequence electrical connections to coordinate with start-up of equipment.

## PART 2 PRODUCTS

### 2.1 CORD AND PLUGS

- A. Manufacturers:
  - 1. Hubbell.
  - 2. Leviton.
  - 3. Bryant.
  - 4. Substitutions: See Division 01- General Requirements.
- B. Attachment Plug Construction: Conform to NEMA WD 1.
- C. Configuration: NEMA WD 6; match receptacle configuration at outlet furnished for equipment.
- D. Cord Construction: Type SO, SJO multi-conductor flexible cord with identified equipment grounding conductor, suitable for use in damp locations.
- E. Size: Suitable for connected load of equipment, length of cord, and rating of branch circuit overcurrent protection.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. See Division 01- General Requirements.
- B. Verify equipment is ready for electrical connection, for wiring, and to be energized.

#### 3.2 INSTALLATION

- A. Make electrical connections.
- B. Make conduit connections to equipment using flexible conduit. Use liquidtight flexible conduit with watertight connectors in damp or wet locations, including pool equipment rooms.
- C. Connect heat producing equipment using wire and cable with insulation suitable for temperatures encountered.
- D. Install receptacle outlet to accommodate connection with attachment plug.
- E. Install cord and cap for field-supplied attachment plug.
- F. Install suitable strain-relief clamps and fittings for cord connections at outlet boxes and equipment connection boxes.
- G. Install disconnect switches, controllers, control stations, safety devices and control devices to complete equipment wiring requirements.
- H. Install fuses, fuse holders and terminal block jumpers to complete equipment wiring requirements.
- I. Install interconnecting conduit and wiring between devices and equipment to complete equipment wiring requirements.
- J. Install conduit and wiring for interconnection of motorized door operator, safety devices and accessories to complete equipment wiring requirements.
- K. Install conduit and wiring for interconnection of specialty equipment (motorized windows, shade controllers...etc.) control stations, safety devices and accessories to complete equipment wiring requirements.
- L. Install conduit and wiring for interconnection of receptacles, lighting and switches furnished with equipment (fume hoods, furnishings...etc.).
- M. Install conduit and wiring for interconnection of alarm initiating devices, control panels and annunciators furnished with equipment.

- N. Install conduit and wiring for interconnection of power supplies furnished by other divisions.
- 3.3 ADJUSTING
- A. See Division 01- General Requirements.
  - B. Cooperate with utilization equipment installers and field service personnel during checkout and starting of equipment to allow testing and balancing and other startup operations. Provide personnel to operate electrical system and checkout wiring connection components and configurations.

END OF SECTION 260503

SECTION 260519 ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Single conductor building wire.
- B. Underground feeder and branch-circuit cable.
- C. Metal-clad cable.
- D. Wiring connectors.
- E. Electrical tape.
- F. Heat shrink tubing.
- G. Oxide inhibiting compound.
- H. Wire pulling lubricant.
- I. Cable ties.

1.2 RELATED REQUIREMENTS

- A. Division 7.--Thermal and Moisture Protection.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems: Additional requirements for grounding conductors and grounding connectors.
- C. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- D. Section 26 4500 - Photovoltaic System: Additional wiring requirements for photovoltaic systems.
- E. Section 28 3100 - Fire Detection and Alarm: Fire alarm system conductors and cables.

1.3 REFERENCE STANDARDS

- A. ASTM B3 - Standard Specification for Soft or Annealed Copper Wire; 2013.
- B. ASTM B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft; 2011.
- C. ASTM B33 - Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes; 2010 (Reapproved 2014).

- D. ASTM B787/B787M - Standard Specification for 19 Wire Combination Unilay-Stranded Copper Conductors for Subsequent Insulation; 2004 (Reapproved 2014).
- E. ASTM B800 - Standard Specification for 8000 Series Aluminum Alloy Wire for Electrical Purposes - Annealed and Intermediate Tempers; 2005 (Reapproved 2015).
- F. ASTM B801 - Standard Specification for Concentric-Lay-Stranded Conductors of 8000 Series Aluminum Alloy Wire for Subsequent Covering of Insulation; 2016.
- G. ASTM D3005 - Standard Specification for Low-Temperature Resistant Vinyl Chloride Plastic Pressure-Sensitive Electrical Insulating Tape; 2010.
- H. ASTM D4388 - Standard Specification for Nonmetallic Semi-Conducting and Electrically Insulating Rubber Tapes; 2013.
- I. FS A-A-59544 - Cable and Wire, Electrical (Power, Fixed Installation); Federal Specification; Revision A, 2008.
- J. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- K. NECA 104 - Recommended Practice for Installing Aluminum Building Wire and Cable; 2012.
- L. NECA 120 - Standard for Installing Armored Cable (AC) and Metal-Clad Cable (MC); 2012.
- M. NEMA WC 70 - Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy; 2009.
- N. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems; 2013.
- O. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- P. UL 44 - Thermoset-Insulated Wires and Cables; Current Edition, Including All Revisions.
- Q. UL 83 - Thermoplastic-Insulated Wires and Cables; Current Edition, Including All Revisions.
- R. UL 486A-486B - Wire Connectors; Current Edition, Including All Revisions.
- S. UL 486C - Splicing Wire Connectors; Current Edition, Including All Revisions.
- T. UL 486D - Sealed Wire Connector Systems; Current Edition, Including All Revisions.
- U. UL 493 - Thermoplastic-Insulated Underground Feeder and Branch-Circuit Cables; Current Edition, Including All Revisions.



- V. UL 510 - Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape; Current Edition, Including All Revisions.
- W. UL 854 - Service-Entrance Cables; Current Edition, Including All Revisions.
- X. UL 1277 - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members; Current Edition, Including All Revisions.
- Y. UL 1569 - Metal-Clad Cables; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate sizes of raceways, boxes, and equipment enclosures installed under other sections with the actual conductors to be installed, including adjustments for conductor sizes increased for voltage drop.
  - 2. Coordinate the installation of direct burial cable with other trades to avoid conflicts with piping or other potential conflicts.
  - 3. Coordinate with electrical equipment installed under other sections to provide terminations suitable for use with the conductors to be installed.
  - 4. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.

#### 1.5 SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for conductors and cables, including detailed information on materials, construction, ratings, listings, and available sizes, configurations, and stranding.
- C. Sustainable Design Documentation: Submit manufacturer's product data on conductor and cable showing compliance with specified lead content requirements.
- D. Manufactured Wiring System Shop Drawings: Provide plan views indicating proposed system layout with components identified; indicate branch circuit connections.
- E. Design Data: Indicate voltage drop and ampacity calculations for aluminum conductors substituted for copper conductors. Include proposed modifications to raceways, boxes, wiring gutters, enclosures, etc. to accommodate substituted conductors.
- F. Field Quality Control Test Reports.
- G. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- H. Project Record Documents: Record actual installed circuiting arrangements. Record actual routing for underground circuits.

- I. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Division 01 – General Requirements.
  
- 1.6 QUALITY ASSURANCE
  - A. Conform to requirements of NFPA 70.
  - B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
  - C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
  - D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
  
- 1.7 DELIVERY, STORAGE, AND HANDLING
  - A. Receive, inspect, handle, and store conductors and cables in accordance with manufacturer's instructions.
  
- 1.8 FIELD CONDITIONS
  - A. Do not install or otherwise handle thermoplastic-insulated conductors at temperatures lower than 14 degrees F, unless otherwise permitted by manufacturer's instructions. When installation below this temperature is unavoidable, notify Architect and obtain direction before proceeding with work.

## PART 2 PRODUCTS

### 2.1 CONDUCTOR AND CABLE APPLICATIONS

- A. Do not use conductors and cables for applications other than as permitted by NFPA 70 and product listing.
- B. Provide single conductor building wire installed in suitable raceway unless otherwise indicated, permitted, or required.
- C. Nonmetallic-sheathed cable is not permitted, unless noted otherwise.
- D. Service entrance cable is not permitted, unless noted otherwise.
- E. Armored cable is not permitted.

- F. Metal-clad cable is permitted as follows:
    - 1. Where not otherwise restricted, may be used:
      - a. Where concealed above accessible ceilings for final connections from junction boxes to luminaires.
        - 1) Maximum Length: 6 feet.
      - b. Where concealed in hollow stud walls, above accessible ceilings, and under raised floors for branch circuits up to 20 A.
        - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from first outlet to panelboard.
    - 2. In addition to other applicable restrictions, may not be used:
      - a. Life Safety or Critical Power.
      - b. Homeruns from first device, such as lighting fixture, MEP equipment, wiring device to panelboards.
      - c. Where not approved for use by the authority having jurisdiction.
      - d. Where exposed to view.
      - e. Where exposed to damage.
      - f. For damp, wet, or corrosive locations.
  - G. Manufactured wiring systems are permitted only as follows:
    - 1. Where not otherwise restricted, may be used:
      - a. For branch circuits where concealed under raised floors, where concealed above accessible ceilings for lighting.
        - 1) Exception: Provide single conductor building wire in raceway for circuit homerun from distribution box to panelboard.
- 2.2 CONDUCTOR AND CABLE GENERAL REQUIREMENTS
- A. Provide products that comply with requirements of NFPA 70.
  - B. Provide products listed, classified, and labeled as suitable for the purpose intended.
  - C. Provide conductors and cables with lead content less than 300 parts per million.
  - D. Provide new conductors and cables manufactured not more than one year prior to installation.
  - E. Unless specifically indicated to be excluded, provide all required conduit, boxes, wiring, connectors, etc. as required for a complete operating system.
  - F. Comply with NEMA WC 70.
  - G. Comply with FS A-A-59544 where applicable.
  - H. Thermoplastic-Insulated Conductors and Cables: Listed and labeled as complying with UL 83.
  - I. Thermoset-Insulated Conductors and Cables: Listed and labeled as complying with UL 44.

- J. Conductors for Grounding and Bonding: Also comply with Section 26 0526.
- K. Conductors and Cables Installed Exposed in Spaces Used for Environmental Air (only where specifically permitted): Plenum rated, listed and labeled as suitable for use in return air plenums.
- L. Conductor Material:
  - 1. Provide copper conductors except where aluminum conductors are specifically indicated or permitted for substitution. Conductor sizes indicated are based on copper unless specifically indicated as aluminum. Conductors designated with the abbreviation "AL" indicate aluminum.
    - a. Substitution of aluminum conductors for copper is permitted, when approved by Engineer, Owner and authority having jurisdiction, only for the following:
      - 1) Services: Copper conductors size 1/0 AWG and larger.
      - 2) Feeders: Copper conductors size 1/0 AWG and larger.
    - b. Where aluminum conductors are substituted for copper, comply with the following:
      - 1) Size aluminum conductors to provide, when compared to copper sizes indicated, equivalent or greater ampacity and equivalent or less voltage drop.
      - 2) Increase size of raceways, boxes, wiring gutters, enclosures, etc. as required to accommodate aluminum conductors.
      - 3) Provide aluminum equipment grounding conductor sized according to NFPA 70.
      - 4) Equip electrical distribution equipment with compression lugs for terminating aluminum conductors.
  - 2. Copper Conductors: Soft drawn annealed, 98 percent conductivity, uncoated copper conductors complying with ASTM B3, ASTM B8, or ASTM B787/B787M unless otherwise indicated.
  - 3. Tinned Copper Conductors: Comply with ASTM B33.
  - 4. Aluminum Conductors (only where specifically indicated): AA-8000 series aluminum alloy conductors recognized by ASTM B800 and compact stranded in accordance with ASTM B801 unless otherwise indicated.
- M. Minimum Conductor Size:
  - 1. Branch Circuits: 12 AWG.
    - a. Exceptions:
      - 1) 20 A, 120 V circuits longer than 75 feet 10 AWG minimum, and sized for voltage drop.
      - 2) 20 A, 120 V circuits longer than 150 feet 8 AWG minimum, and sized for voltage drop.
      - 3) 20 A, 277 V circuits longer than 150 feet: 10 AWG minimum, and sized for voltage drop.
  - 2. Control Circuits: 14 AWG.
- N. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.

- O. Conductor Color Coding:
  - 1. Color code conductors as indicated unless otherwise required by the authority having jurisdiction. Maintain consistent color coding throughout project.
  - 2. Color Coding Method: Integrally colored insulation.
    - a. Conductors size 4 AWG and larger may have black insulation color coded using vinyl color coding electrical tape.
  - 3. Color Code:
    - a. 480Y/277 V, 3 Phase, 4 Wire System:
      - 1) Phase A: Brown.
      - 2) Phase B: Orange.
      - 3) Phase C: Yellow.
      - 4) Neutral/Grounded: Gray.
    - b. 208Y/120 V, 3 Phase, 4 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
      - 4) Neutral/Grounded: White.
    - c. 240/120 V, 1 Phase, 3 Wire System:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Neutral/Grounded: White.
    - d. Equipment Ground, All Systems: Green.
    - e. Isolated Ground, All Systems: Green with yellow stripe.
    - f. Travelers for 3-Way and 4-Way Switching: Pink.
    - g. For modifications or additions to existing wiring systems, comply with existing color code when existing code complies with NFPA 70 and is approved by the authority having jurisdiction.
    - h. For control circuits, comply with manufacturer's recommended color code.

### 2.3 SINGLE CONDUCTOR BUILDING WIRE

- A. Manufacturers:
  - 1. Copper Building Wire:
    - a. Cerro Wire LLC
    - b. Southwire Company
    - c. General Cable Technologies.
    - d. Substitutions: See Section 01 - Product Requirements.
  - 2. Aluminum Building Wire (only where specifically indicated):
    - a. Encore Wire Corporation
    - b. Southwire Company
    - c. Stabiloy, a brand of General Cable Technologies Corporation
    - d. Substitutions: See Section 01 - Product Requirements.
- B. Description: Single conductor insulated wire.

- C. Conductor Stranding:
  - 1. Feeders and Branch Circuits:
    - a. Size 10 AWG and Smaller: Solid.
    - b. Size 8 AWG and Larger: Stranded.
  - 2. Control Circuits: Stranded.
- D. Insulation Voltage Rating: 600 V.
- E. Insulation:
  - 1. Copper Building Wire: Type THHN/THWN or THHN/THWN-2, except as indicated below.
    - a. Installed Underground: Type XHHW-2.
  - 2. Aluminum Building Wire (only where specifically indicated): Type XHHW-2.

#### 2.4 UNDERGROUND FEEDER AND BRANCH-CIRCUIT CABLE

- A. Manufacturers:
  - 1. Cerro Wire LLC.
  - 2. Encore Wire Corporation.
  - 3. Southwire Company.
  - 4. General Cable Technologies.
  - 5. Substitutions: See Section 01 - Product Requirements.
- B. Description: Single conductor insulated wire.
- C. Provide equipment grounding conductor unless otherwise indicated.
- D. Conductor Stranding:
  - 1. Size 10 AWG and Smaller: Solid.
  - 2. Size 8 AWG and Larger: Stranded.
- E. Insulation Voltage Rating: 600 V.
- F. Insulation: Type XHHW-2.

#### 2.5 METAL-CLAD CABLE

- A. Manufacturers:
  - 1. AFC Cable Systems Inc.
  - 2. Encore Wire Corporation.
  - 3. Southwire Company.
  - 4. General Cable Technologies.
  - 5. Substitutions: See Section 01 - Product Requirements.
- B. Description: NFPA 70, Type MC cable listed and labeled as complying with UL 1569, and listed for use in classified firestop systems to be used.

- C. Conductor Stranding:
    - 1. Size 10 AWG and Smaller: Solid.
    - 2. Size 8 AWG and Larger: Stranded.
  - D. Insulation Voltage Rating: 600 V.
  - E. Insulation: Type THHN, THHN/THWN, or THHN/THWN-2.
  - F. Provide oversized neutral conductors where indicated or required.
  - G. Provide dedicated neutral conductor for each phase conductor where indicated or required.
  - H. Grounding: Full-size integral equipment grounding conductor.
    - 1. Provide additional isolated/insulated grounding conductor where indicated or required.
  - I. Armor: Steel, interlocked tape.
  - J. Provide PVC jacket applied over cable armor where indicated or required for environment of installed location.
- 2.6 WIRING CONNECTORS
- A. Description: Wiring connectors appropriate for the application, suitable for use with the conductors to be connected, and listed as complying with UL 486A-486B or UL 486C as applicable.
  - B. Connectors for Grounding and Bonding: Comply with Section 26 0526.
  - C. Wiring Connectors for Splices and Taps:
    - 1. Copper conductors 10 AWG and smaller: Install insulated spring wire connectors with plastic caps
    - 2. Copper Conductors Size 8 AWG: Install solderless pressure connectors with insulating covers
    - 3. Copper Conductors Size 6 AWG and larger: Install pressure connectors or split bolt connectors.
    - 4. Connectors for Aluminum Conductors: Use compression connectors.
  - D. Wiring Connectors for Terminations:
    - 1. Provide terminal lugs for connecting conductors to equipment furnished with terminations designed for terminal lugs.
    - 2. Provide compression adapters for connecting conductors to equipment furnished with mechanical lugs when only compression connectors are specified.
    - 3. Where over-sized conductors are larger than the equipment terminations can accommodate, provide connectors suitable for reducing to appropriate size, but not less than required for the rating of the overcurrent protective device.

4. Provide motor pigtail connectors for connecting motor leads in order to facilitate disconnection.
  5. Copper Conductors Size 8 AWG and Larger: Use mechanical connectors or compression connectors where connectors are required.
  6. Aluminum Conductors: Use compression connectors for all connections.
  7. Stranded Conductors Size 10 AWG and Smaller: Use crimped terminals for connections to terminal screws.
  8. Conductors for Control Circuits: Use crimped terminals for all connections.
- E. Do not use insulation-piercing or insulation-displacement connectors designed for use with conductors without stripping insulation.
- F. Do not use push-in wire connectors as a substitute for twist-on insulated spring connectors.
- G. Twist-on Insulated Spring Connectors: Rated 600 V, 221 degrees F for standard applications and 302 degrees F for high temperature applications; pre-filled with sealant and listed as complying with UL 486D for damp and wet locations.
1. Manufacturers:
    - a. 3M
    - b. Ideal Industries, Inc
    - c. NSI Industries LLC
    - d. IlSCO.
    - e. Erico.
    - f. Substitutions: See Division 01 – General Requirements..
- H. Mechanical Connectors: Provide bolted type or set-screw type.
1. Manufacturers:
    - a. Burndy LLC
    - b. IlSCO
    - c. Thomas & Betts Corporation
    - d. Substitutions: See Division 01 – General Requirements..
- I. Compression Connectors: Provide circumferential type or hex type crimp configuration.
1. Manufacturers:
    - a. Burndy LLC
    - b. IlSCO
    - c. Thomas & Betts Corporation
    - d. Erico.
    - e. Substitutions: See Division 01 – General Requirements..
- J. Crimped Terminals: Nylon-insulated, with insulation grip and terminal configuration suitable for connection to be made.
1. Manufacturers:
    - a. Burndy LLC
    - b. IlSCO
    - c. Thomas & Betts Corporation.
    - d. Substitutions: See Division 01 – General Requirements.



## 2.7 WIRING ACCESSORIES

- A. Electrical Tape:
  - 1. Manufacturers:
    - a. 3M
    - b. Plymouth Rubber Europa
    - c. Substitutions: See Division 01 – General Requirements..
  - 2. Vinyl Color Coding Electrical Tape: Integrally colored to match color code indicated; listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; suitable for continuous temperature environment up to 221 degrees F .
  - 3. Vinyl Insulating Electrical Tape: Complying with ASTM D3005 and listed as complying with UL 510; minimum thickness of 7 mil; resistant to abrasion, corrosion, and sunlight; conformable for application down to 0 degrees F and suitable for continuous temperature environment up to 221 degrees F.
  - 4. Rubber Splicing Electrical Tape: Ethylene Propylene Rubber (EPR) tape, complying with ASTM D4388; minimum thickness of 30 mil; suitable for continuous temperature environment up to 194 degrees F and short-term 266 degrees F overload service.
  
- B. Heat Shrink Tubing: Heavy-wall, split-resistant, with factory-applied adhesive; rated 600 V; suitable for direct burial applications; listed as complying with UL 486D.
  - 1. Manufacturers:
    - a. 3M
    - b. Burndy LLC
    - c. Thomas & Betts Corporation
    - d. Substitutions: See Division 01 – General Requirements..
  
- C. Oxide Inhibiting Compound: Listed; suitable for use with the conductors or cables to be installed.
  - 1. Manufacturers:
    - a. Burndy LLC
    - b. Ideal Industries, Inc
    - c. IlSCO
    - d. Substitutions: See Division 01 – General Requirements..
  
- D. Wire Pulling Lubricant: Listed; suitable for use with the conductors or cables to be installed and suitable for use at the installation temperature.
  - 1. Manufacturers:
    - a. 3M
    - b. American Polywater Corporation
    - c. Ideal Industries, Inc
    - d. Substitutions: See Division 01 – General Requirements..

- E. Cable Ties: Material and tensile strength rating suitable for application.
  - 1. Manufacturers:
    - a. Burndy LLC
    - b. Substitutions: See Section 01 - Product Requirements.
  - 2. Provide plenum rated cable ties for return air plenum applications.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that interior of building has been protected from weather.
- B. Verify that work likely to damage wire and cable has been completed.
- C. Verify that raceways, boxes, and equipment enclosures are installed and are properly sized to accommodate conductors and cables in accordance with NFPA 70.
- D. Verify that field measurements are as shown on the drawings.
- E. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.2 PREPARATION

- A. Clean raceways thoroughly to remove foreign materials before installing conductors and cables.

#### 3.3 INSTALLATION

- A. Circuiting Requirements:
  - 1. Unless dimensioned, circuit routing indicated is diagrammatic.
  - 2. When circuit destination is indicated and routing is not shown, determine exact routing required.
  - 3. Arrange circuiting to minimize splices.
  - 4. Maintain separation of Class 1, Class 2, and Class 3 remote-control, signaling, and power-limited circuits in accordance with NFPA 70.
  - 5. Maintain separation of wiring for emergency systems in accordance with NFPA 70.
  - 6. Circuiting Adjustments: Unless otherwise indicated, when branch circuits are shown as separate, combining them together in a single raceway is not permitted  
Where indicated:
    - a. Dedicated neutral conductors are considered current-carrying conductors.
    - b. Increase size of conductors as required accounting for ampacity derating.
    - c. Size raceways, boxes, etc. to accommodate conductors.
  - 7. Common Neutrals: Not allowed.
- B. Install products in accordance with manufacturer's instructions.

- C. Perform work in accordance with NECA 1 (general workmanship).
- D. Install aluminum conductors in accordance with NECA 104.
- E. Install metal-clad cable (Type MC) in accordance with NECA 120.
- F. Installation in Raceway:
  - 1. Tape ends of conductors and cables to prevent infiltration of moisture and other contaminants.
  - 2. Pull all conductors and cables together into raceway at same time.
  - 3. Do not damage conductors and cables or exceed manufacturer's recommended maximum pulling tension and sidewall pressure.
  - 4. Use suitable wire pulling lubricant where necessary, except when lubricant is not recommended by the manufacturer.
- G. Paralleled Conductors: Install conductors of the same length and terminate in the same manner.
- H. Secure and support conductors and cables in accordance with NFPA 70 using suitable supports and methods approved by the authority having jurisdiction. Provide independent support from building structure. Do not provide support from raceways, piping, ductwork, or other systems.
  - 1. Installation Above Suspended Ceilings: Do not provide support from ceiling support system. Do not provide support from ceiling grid or allow conductors and cables to lay on ceiling tiles.
  - 2. Installation in Vertical Raceways: Provide supports where vertical rise exceeds permissible limits.
- I. Terminate cables using suitable fittings.
  - 1. Metal-Clad Cable (Type MC):
    - a. Use listed fittings.
    - b. Cut cable armor only using specialized tools to prevent damaging conductors or insulation. Do not use hacksaw or wire cutters to cut armor.
    - c. Do not use direct-bearing set-screw type fittings for cables with aluminum armor.
    - d. Secure at maximum interval of 5 ft.
    - e. Install parallel and perpendicular to building lines.
    - f. Bundle cables in common routes back to panelboards.
    - g. Secure from structure using suitable J-hooks or plenum rated cable ties.
- J. Install conductors with a minimum of 12 inches of slack at each outlet.
- K. Where conductors are installed in enclosures for future termination by others, provide a minimum of 5 feet of slack.
- L. Neatly train and bundle conductors inside boxes, wireways, panelboards and other equipment enclosures.

- M. Group or otherwise identify neutral/grounded conductors with associated ungrounded conductors inside enclosures in accordance with NFPA 70.
  
- N. Make wiring connections using specified wiring connectors.
  - 1. Make splices and taps only in accessible boxes. Do not pull splices into raceways or make splices in conduit bodies or wiring gutters.
  - 2. Do not remove conductor strands to facilitate insertion into connector.
  - 3. Clean contact surfaces on conductors and connectors to suitable remove corrosion, oxides, and other contaminates. Do not use wire brush on plated connector surfaces.
  - 4. Connections for Aluminum Conductors: Fill connectors with oxide inhibiting compound where not pre-filled by manufacturer.
  - 5. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  - 6. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
  
- O. Insulate splices and taps that are made with uninsulated connectors using methods suitable for the application, with insulation and mechanical strength at least equivalent to unspliced conductors.
  - 1. Dry Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
    - a. For taped connections, first apply adequate amount of rubber splicing electrical tape or electrical filler tape, followed by outer covering of vinyl insulating electrical tape.
    - b. For taped connections likely to require re-entering, including motor leads, first apply varnished cambric electrical tape, followed by adequate amount of rubber splicing electrical tape, followed by outer covering of vinyl insulating electrical tape.
  - 2. Damp Locations: Use insulating covers specifically designed for the connectors, electrical tape, or heat shrink tubing.
    - a. For connections with insulating covers, apply outer covering of moisture sealing electrical tape.
    - b. For taped connections, follow same procedure as for dry locations but apply outer covering of moisture sealing electrical tape.
  - 3. Wet Locations: Use heat shrink tubing.
  
- P. Insulate ends of spare conductors using vinyl insulating electrical tape.
  
- Q. Field-Applied Color Coding: Where vinyl color coding electrical tape is used in lieu of integrally colored insulation as permitted in Part 2 under "Color Coding", apply half overlapping turns of tape at each termination and at each location conductors are accessible.
  
- R. Identify conductors and cables in accordance with Section 26 0553.
  
- S. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified in Section 07.

- T. Unless specifically indicated to be excluded, provide final connections to all equipment and devices, including those furnished by others, as required for a complete operating system.
- 3.4 FIELD QUALITY CONTROL
- A. See Division 01 – General Requirements.
  - B. Inspect and test in accordance with NETA ATS, except Section 4.
  - C. Perform inspections and tests listed in NETA ATS, Section 7.3.2. The insulation resistance test is required for all conductors. The resistance test for parallel conductors listed as optional is not required.
    - 1. Disconnect surge protective devices (SPDs) prior to performing any high potential testing. Replace SPDs damaged by performing high potential testing with SPDs connected.
  - D. Correct deficiencies and replace damaged or defective conductors and cables.

END OF SECTION 260519

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SECTION 260526 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Grounding and bonding requirements.
- B. Conductors for grounding and bonding.
- C. Connectors for grounding and bonding.
- D. Ground bars.
- E. Ground rod electrodes.
- F. Chemically-enhanced ground electrodes.
- G. Ground plate electrodes.
- H. Ground enhancement material.
- I. Ground access wells.
- J. Pre-fabricated signal reference grids.

1.2 RELATED REQUIREMENTS

- A. Division 01 – General Requirements
- B. Division 03– Concrete.
- C. Division 09 - Finishes.
- D. Section 26 0400 – General Conditions for Electrical Trades
- E. Section 26 0519 - Low-Voltage Electrical Power Conductors and Cables: Additional requirements for conductors for grounding and bonding, including conductor color coding.
  - 1. Includes oxide inhibiting compound.
- F. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- G. Section 264500 - Photovoltaic Systems: Additional grounding and bonding requirements for photovoltaic systems.
- H. Section 26 4113 – Lightning Protection for Structures.

- I. Section 33 7900 - Site Grounding.
- 1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)
- A. IEEE 81 - IEEE Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Grounding System.
  - B. NECA 1 - Standard for Good Workmanship in Electrical Construction.
  - C. NEMA GR 1 - Grounding Rod Electrodes and Grounding Rod Electrode Couplings.
  - D. NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
  - E. NFPA 70 - National Electrical Code.
  - F. NFPA 780 - Standard for the Installation of Lightning Protection Systems.
  - G. UL 467 - Grounding and Bonding Equipment.
- 1.4 ADMINISTRATIVE REQUIREMENTS
- A. Coordination:
    - 1. Verify exact locations of underground metal water service pipe entrances to building.
    - 2. Coordinate the work with other trades to provide steel reinforcement complying with specified requirements for concrete-encased electrode.
    - 3. Notify Architect of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
  - B. Sequencing:
    - 1. Do not install ground rod electrodes until final backfill and compaction is complete.
- 1.5 SUBMITTALS
- A. See Division 01 – General Requirements.
  - B. Product Data: Provide manufacturer's standard catalog pages and data sheets for grounding and bonding system components.
  - C. Shop Drawings:
    - 1. Indicate proposed arrangement for signal reference grids. Include locations of items to be bonded and methods of connection.
  - D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.



- E. Field quality control test reports.
  - F. Project Record Documents: Record actual locations of grounding electrode system components and connections.
- 1.6 QUALITY ASSURANCE
- A. Conform to requirements of NFPA 70.
  - B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
  - C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
  - D. Installer Qualifications for Signal Reference Grids: Company with minimum five years documented experience with high frequency grounding systems.
  - E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- 1.7 DELIVERY, STORAGE, AND HANDLING
- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

## PART 2 PRODUCTS

### 2.1 GROUNDING AND BONDING REQUIREMENTS

- A. Do not use products for applications other than as permitted by NFPA 70 and product listing.
- B. Unless specifically indicated to be excluded, provide all required components, conductors, connectors, conduit, boxes, fittings, supports, accessories, etc. as necessary for a complete grounding and bonding system.
- C. Where conductor size is not indicated, size to comply with NFPA 70 but not less than applicable minimum size requirements specified.
- D. Grounding System Resistance:
  - 1. Achieve specified grounding system resistance under normally dry conditions unless otherwise approved by Architect. Precipitation within the previous 48 hours does not constitute normally dry conditions.
  - 2. Grounding Electrode System: Not greater than 5 ohms to ground, when tested according to IEEE 81 using "fall-of-potential" method.

3. Between Grounding Electrode System and Major Electrical Equipment Frames, System Neutral, and Derived Neutral Points: Not greater than 0.5 ohms, when tested using "point-to-point" methods.
- E. Grounding Electrode System:
1. Provide connection to required and supplemental grounding electrodes indicated to form grounding electrode system.
    - a. Provide continuous grounding electrode conductors without splice or joint.
    - b. Install grounding electrode conductors in raceway where exposed to physical damage. Bond grounding electrode conductor to metallic raceways at each end with bonding jumper.
  2. Metal Underground Water Pipe(s):
    - a. Provide connection to underground metal domestic and fire protection (where present) water service pipe(s) that are in direct contact with earth for at least 10 feet at an accessible location not more than 5 feet from the point of entrance to the building.
    - b. Provide bonding jumper(s) around insulating joints/pipes as required to make pipe electrically continuous.
    - c. Provide bonding jumper around water meter of sufficient length to permit removal of meter without disconnecting jumper.
  3. Other Metal Piping:
    - a. Provide connection to all metallic gas piping and miscellaneous metal piping of continuous lengths.
    - b. Bond in accordance with NFPA 70.
    - c. Size bonding conductor in accordance with NFPA 70.
  4. Metal In-Ground Support Structure:
    - a. Provide connection to metal in-ground support structure that is in direct contact with earth in accordance with NFPA 70.
  5. Concrete-Encased Electrode:
    - a. Provide connection to concrete-encased electrode consisting of not less than 20 feet of either steel reinforcing bars or bare copper conductor not smaller than 4 AWG embedded within concrete foundation or footing that is in direct contact with earth in accordance with NFPA 70.
  6. Ground Rod Electrode(s):
    - a. Provide three electrodes in an equilateral triangle configuration unless otherwise indicated or required.
    - b. Space electrodes not less than 22 feet from each other and any other ground electrode.
    - c. Where location is not indicated, locate electrode(s) at least 5 feet outside building perimeter foundation as near as possible to electrical service entrance; where possible, locate in softscape (uncovered) area.
    - d. Provide ground enhancement material around electrode where indicated.
    - e. Provide ground access well for each electrode.
  7. Provide additional ground electrode(s) as required to achieve specified grounding electrode system resistance.

8. Ground Bar: Provide ground bar, separate from service equipment enclosure, for common connection point of grounding electrode system bonding jumpers as permitted in NFPA 70. Connect grounding electrode conductor provided for service-supplied system grounding to this ground bar.
    - a. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
    - b. Where ground bar location is not indicated, locate in accessible location as near as possible to service disconnect enclosure.
    - c. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
  9. Ground Riser: Provide common grounding electrode conductor not less than 3/0 AWG for tap connections to multiple separately derived systems as permitted in NFPA 70.
- F. Service-Supplied System Grounding:
1. For each service disconnect, provide grounding electrode conductor to connect neutral (grounded) service conductor to grounding electrode system. Unless otherwise indicated, make connection at neutral (grounded) bus in service disconnect enclosure.
  2. For each service disconnect, provide main bonding jumper to connect neutral (grounded) bus to equipment ground bus where not factory-installed. Do not make any other connections between neutral (grounded) conductors and ground on load side of service disconnect.
- G. Grounding for Separate Building or Structure Supplied by Feeder(s) or Branch Circuits:
1. Provide grounding electrode system for each separate building or structure.
  2. Provide equipment grounding conductor routed with supply conductors.
  3. For each disconnecting means, provide grounding electrode conductor to connect equipment ground bus to grounding electrode system.
  4. Do not make any connections and remove any factory-installed jumpers between neutral (grounded) conductors and ground.
- H. Separately Derived System Grounding:
1. Separately derived systems include, but are not limited to:
    - a. Transformers (except autotransformers such as buck-boost transformers).
    - b. Uninterruptible power supplies (UPS), when configured as separately derived systems.
    - c. Generators, when neutral is switched in the transfer switch.
  2. Provide grounding electrode conductor to connect derived system grounded conductor to nearest effectively grounded metal building frame. Unless otherwise indicated, make connection at neutral (grounded) bus in source enclosure.
  3. Provide bonding jumper to connect derived system grounded conductor to nearest metal building frame and nearest metal water piping in the area served by the derived system, where not already used as a grounding electrode for the derived system. Make connection at same location as grounding electrode conductor connection.
  4. Where common grounding electrode conductor ground riser is used for tap connections to multiple separately derived systems, provide bonding jumper to

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- connect the metal building frame and metal water piping in the area served by the derived system to the common grounding electrode conductor.
  5. Outdoor Source: Where the source of the separately derived system is located outside the building or structure supplied, provide connection to grounding electrode at source in accordance with NFPA 70.
  6. Provide system bonding jumper to connect system grounded conductor to equipment ground bus. Make connection at same location as grounding electrode conductor connection. Do not make any other connections between neutral (grounded) conductors and ground on load side of separately derived system disconnect.
  7. Where the source and first disconnecting means are in separate enclosures, provide supply-side bonding jumper between source and first disconnecting means.
- I. Bonding and Equipment Grounding:
1. Provide bonding for equipment grounding conductors, equipment ground busses, metallic equipment enclosures, metallic raceways and boxes, device grounding terminals, and other normally non-current-carrying conductive materials enclosing electrical conductors/equipment or likely to become energized as indicated and in accordance with NFPA 70.
  2. Provide insulated equipment grounding conductor in each feeder and branch circuit raceway. Do not use raceways as sole equipment grounding conductor.
  3. Where circuit conductor sizes are increased for voltage drop, increase size of equipment grounding conductor proportionally in accordance with NFPA 70.
  4. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
  5. Terminate branch circuit equipment grounding conductors on solidly bonded equipment ground bus only. Do not terminate on neutral (grounded) or isolated/insulated ground bus.
  6. Provide bonding jumper across expansion or expansion/deflection fittings provided to accommodate conduit movement.
  7. Provide bonding for interior metal piping systems in accordance with NFPA 70. This includes, but is not limited to:
    - a. Metal water piping where not already effectively bonded to metal underground water pipe used as grounding electrode.
    - b. Metal gas piping.
    - c. Metal process piping.
  8. Provide bonding for interior metal air ducts.
  9. Provide bonding for metal building frame.
  10. Provide bonding for metal siding not effectively bonded through attachment to metal building frame.
  11. Provide bonding and equipment grounding for pools and fountains and associated equipment in accordance with NFPA 70.
  12. Provide redundant grounding and bonding for patient care areas of health care facilities in accordance with NFPA 70 and NFPA 99.

- J. Isolated Ground System:
    - 1. Where isolated ground receptacles or other isolated ground connections are indicated, provide separate isolated/insulated equipment grounding conductors.
    - 2. Connect isolated/insulated equipment grounding conductors only to separate isolated/insulated equipment ground busses.
    - 3. Connect the isolated/insulated equipment grounding conductors to the solidly bonded equipment ground bus only at the service disconnect or separately derived system disconnect. Do not make any other connections between isolated ground system and normal equipment ground system on the load side of this connection.
  
  - K. Communications Systems Grounding and Bonding:
    - 1. Provide intersystem bonding termination at service equipment or metering equipment enclosure and at disconnecting means for any additional buildings or structures in accordance with NFPA 70.
    - 2. Provide bonding jumper in raceway from intersystem bonding termination to each communications room or backboard and provide ground bar for termination.
      - a. Bonding Jumper Size: 6 AWG, unless otherwise indicated or required.
      - b. Raceway Size: 3/4 inch trade size unless otherwise indicated or required.
      - c. Ground Bar Size: 1/4 by 2 by 12 inches unless otherwise indicated or required.
      - d. Ground Bar Mounting Height: 18 inches above finished floor unless otherwise indicated.
  
  - L. Facility Lightning Protection Systems, in Addition to Requirements of Section 26 4113:
    - 1. Do not use grounding electrode dedicated for lightning protection system for component of building grounding electrode system provided under this section.
    - 2. Provide bonding of building grounding electrode system provided under this section and lightning protection grounding electrode system in accordance with NFPA 70 and NFPA 780.
  
  - M. Photovoltaic Systems: Also comply with Section 26 4500.
  
  - N. Pole-Mounted Luminaires: Also comply with Section 26 5100.
- 2.2 GROUNDING AND BONDING COMPONENTS
- A. General Requirements:
    - 1. Provide products listed, classified, and labeled as suitable for the purpose intended.
    - 2. Provide products listed and labeled as complying with UL 467 where applicable.
  
  - B. Conductors for Grounding and Bonding, in Addition to Requirements of Section 26 0526:
    - 1. Use insulated copper conductors unless otherwise indicated.
      - a. Exceptions:
        - 1) Use bare copper conductors where installed underground in direct contact with earth.

- 2) Use bare copper conductors where directly encased in concrete (not in raceway).
  2. Factory Pre-fabricated Bonding Jumpers: Furnished with factory-installed ferrules; size braided cables to provide equivalent gage of specified conductors.
- C. Connectors for Grounding and Bonding:
1. Description: Connectors appropriate for the application and suitable for the conductors and items to be connected; listed and labeled as complying with UL 467.
  2. Unless otherwise indicated, use exothermic welded connections for underground, concealed and other inaccessible connections.
    - a. Exceptions:
      - 1) Use mechanical connectors for connections to electrodes at ground access wells.
  3. Unless otherwise indicated, use mechanical connectors, compression connectors, or exothermic welded connections for accessible connections.
    - a. Exceptions:
      - 1) Use exothermic welded connections for connections to metal building frame.
  4. Manufacturers - Mechanical and Compression Connectors:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
    - b. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - c. Harger Lightning & Grounding: [www.harger.com](http://www.harger.com).
    - d. Thomas & Betts Corporation: [www.tnb.com](http://www.tnb.com).
    - e. Substitutions: See Division 1 - General Requirements.
  5. Manufacturers - Exothermic Welded Connections:
    - a. Burndy LLC: [www.burndy.com](http://www.burndy.com).
    - b. Cadweld, a brand of Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. ThermOweld, a brand of Continental Industries, Inc: [www.thermoweld.com](http://www.thermoweld.com).
    - d. Substitutions: See Division 1 - General Requirements.
- D. Ground Bars:
1. Description: Copper rectangular ground bars with mounting brackets and insulators.
  2. Size: As indicated.
  3. Holes for Connections: As indicated or as required for connections to be made.
  4. Manufacturers:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
    - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. Harger Lightning & Grounding: [www.harger.com](http://www.harger.com).
    - d. ThermOweld, a brand of Continental Industries, Inc: [www.thermoweld.com](http://www.thermoweld.com).
    - e. Substitutions: See Division 1 - General Requirements.
- E. Ground Rod Electrodes:
1. Comply with NEMA GR 1.
  2. Material: Copper-bonded (copper-clad) steel.
  3. Size: 3/4 inch diameter by 10 feet length, unless otherwise indicated.

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4. Where rod lengths of greater than 10 feet are indicated or otherwise required, sectionalized ground rods may be used.
  5. Manufacturers:
    - a. Advanced Lightning Technology (ALT): [www.altfab.com](http://www.altfab.com).
    - b. Erico International Corporation: [www.erico.com](http://www.erico.com).
    - c. Galvan Industries, Inc: [www.galvanelectrical.com](http://www.galvanelectrical.com).
    - d. Harger Lightning & Grounding: [www.harger.com](http://www.harger.com).
    - e. Substitutions: See Division 1 - General Requirements.
- F. Chemically-Enhanced Ground Electrodes:
1. Description: Copper tube factory-filled with electrolytic salts designed to provide a low-impedance ground in locations with high soil resistivity; straight (for vertical installations) or L-shaped (for horizontal installations) as indicated or as required.
  2. Length: 10 feet.
  3. Integral Pigtail: Factory-attached, sized not less than grounding electrode conductor to be attached.
  4. Backfill Material: Grounding enhancement material recommended by electrode manufacturer.
  5. Manufacturers:
    - a. Advanced Lightning Technology (ALT).
    - b. Erico International Corporation.
    - c. Harger Lightning & Grounding.
    - d. ThermOweld, subsidiary of Continental Industries.
    - e. Substitutions: See Division 1 - General Requirements.
- G. Ground Plate Electrodes:
1. Material: Copper.
  2. Size: 24 by 24 by 1/4 inches , unless otherwise indicated.
  3. Manufacturers:
    - a. Advanced Lightning Technology (ALT).
    - b. Erico International Corporation.
    - c. Harger Lightning & Grounding.
    - d. ThermOweld, subsidiary of Continental Industries: .
    - e. Substitutions: See Division 1 - General Requirements.
- H. Ground Enhancement Material:
1. Description: Factory-mixed conductive material designed for permanent and maintenance-free improvement of grounding effectiveness by lowering resistivity.
  2. Resistivity: Not more than 20 ohm-cm in final installed form.
  3. Manufacturers:
    - a. Erico International Corporation.
    - b. Harger Lightning & Grounding.
    - c. ThermOweld, subsidiary of Continental Industries.
    - d. Substitutions: See Division 1 - General Requirements.



- I. Ground Access Wells:
  - 1. Description: Open bottom round or rectangular well with access cover for testing and inspection; suitable for the expected load at the installed location.
    - a. Areas Exposed to Light Vehicular Traffic: Rated for not less than 22,500 pounds vertical design load.
  - 2. Size: As required to provide adequate access for testing and inspection, but not less than minimum size requirements specified.
    - a. Round Wells: Not less than 8 inches in diameter.
    - b. Rectangular Wells: Not less than 12 by 12 inches .
  - 3. Depth: As required to extend below frost line to prevent frost upheaval, but not less than 42 inches.
  - 4. Cover: Factory-identified by permanent means with word "GROUND".
  - 5. Manufacturers:
    - a. Advanced Lightning Technology (ALT).
    - b. Erico International Corporation.
    - c. Harger Lightning & Grounding.
    - d. ThermOweld, subsidiary of Continental Industries:  
www.thermoweld.com.
    - e. Substitutions: See Division 1 - General Requirements.
  
- J. Oxide Inhibiting Compound: Comply with Section 26 0519.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that work likely to damage grounding and bonding system components has been completed.
- B. Verify that field measurements are as shown on the drawings.
- C. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.2 PREPARATION

- A. Remove paint, rust, mill oils, surface contaminants at connection points.

#### 3.3 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).



- C. Ground Rod Electrodes: Unless otherwise indicated, install ground rod electrodes vertically. Where encountered rock prohibits vertical installation, install at 45 degree angle or bury horizontally in trench at least 30 inches deep in accordance with NFPA 70 or provide ground plates.
  - 1. Outdoor Installations: Unless otherwise indicated, install with top of rod 6 inches below finished grade.
  - 2. Indoor Installations: Unless otherwise indicated, install with 4 inches of top of rod exposed.
- D. Ground Plate Electrodes: Unless otherwise indicated, install ground plate electrodes at a depth of not less than 30 inches.
- E. Make grounding and bonding connections using specified connectors.
  - 1. Remove appropriate amount of conductor insulation for making connections without cutting, nicking or damaging conductors. Do not remove conductor strands to facilitate insertion into connector.
  - 2. Remove nonconductive paint, enamel, or similar coating at threads, contact points, and contact surfaces.
  - 3. Exothermic Welds: Make connections using molds and weld material suitable for the items to be connected in accordance with manufacturer's recommendations.
  - 4. Mechanical Connectors: Secure connections according to manufacturer's recommended torque settings.
  - 5. Compression Connectors: Secure connections using manufacturer's recommended tools and dies.
- F. Install in accordance with IEEE 142.
- G. Install rod electrodes at locations as indicated on Drawings. Install additional rod electrodes to achieve specified resistance to ground.
- H. Install grounding and bonding conductors concealed from view.
- I. Equipment Grounding Conductor: Install separate, insulated conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
- J. Install continuous grounding using underground cold water system, driven rods and building steel as grounding electrode. Where water piping is not available, install artificial station ground by means of driven rods or buried electrodes.
- K. Permanently ground entire light and power system in accordance with NEC, including service equipment, distribution panels, lighting panelboards, switch and starter enclosures, motor frames, grounding type receptacles, and other exposed non-current carrying metal parts of electrical equipment.
- L. Accomplish grounding of electrical system by using insulated grounding conductor installed with feeders and branch circuit conductors in conduits. Size grounding conductors in accordance with NEC. Install from grounding bus of serving panel to

ground bus of served panel, grounding screw of receptacles, lighting fixture housing, light switch outlet boxes or metal enclosures of service equipment. Ground conduits by means of grounding bushings on terminations at panelboards with installed number 12 conductor to grounding bus.

- M. Permanently attach equipment and grounding conductors prior to energizing equipment.
  - N. Common Ground Bonding with Lightning Protection System: Bond electric power system, grounding electrode system directly to lightning protection system earth connection at closest point to electric service grounding electrode. Use bonding conductor sized the same as system grounding conductor and install in conduit.
  - O. Identify grounding and bonding system components in accordance with Section 26 0553.
- 3.4 FIELD QUALITY CONTROL
- A. See Division 01 - General Requirements.
  - B. Inspect and test in accordance with NETA ATS except Section 4.
  - C. Perform inspections and tests listed in NETA ATS, Section 7.13.
  - D. Perform ground electrode resistance tests under normally dry conditions. Precipitation within the previous 48 hours does not constitute normally dry conditions.
  - E. Investigate and correct deficiencies where measured ground resistances do not comply with specified requirements.
  - F. Submit detailed reports indicating inspection and testing results and corrective actions taken.

END OF SECTION 260526

SECTION 260529 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Support and attachment components for electrical equipment, conduit, cable, boxes, and other electrical work.

1.2 RELATED REQUIREMENTS

- A. Division 03 - Cast-in-Place Concrete: Concrete equipment pads.
- B. Section 26 0533 - Conduit: Additional support and attachment requirements for conduits.
- C. Section 26 0533 - Boxes: Additional support and attachment requirements for boxes.
- D. Section 26 4500 - Photovoltaic Collectors: Photovoltaic module mounting systems.
- E. Section 26 51 00 - Lighting: Additional support and attachment requirements for interior luminaires.

1.3 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products; 2015.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware; 2016a.
- C. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel; 2015.
- D. MFMA-4 - Metal Framing Standards Publication; 2004.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- G. UL 5B - Strut-Type Channel Raceways and Fittings; Current Edition, Including All Revisions.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Division 01: Requirements for Coordination.

- B. Coordination:
    - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
    - 2. Coordinate the work with other trades and ~~to~~ provide additional framing and materials required for installation.
    - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
    - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
    - 5. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain direction before proceeding with work.
  - C. Sequencing:
    - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Division 03.
- 1.5 SUBMITTALS
- A. See Division 01 - General Requirements, for submittal procedures.
  - B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, non-penetrating rooftop supports, and post-installed concrete and masonry anchors.
  - C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.
  - D. Installer's Qualifications: Include evidence of compliance with specified requirements.
  - E. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- 1.6 QUALITY ASSURANCE
- A. Comply with NFPA 70.
  - B. Comply with latest adopted version of applicable building code, including any addendum or supplements.
  - C. Installer Qualifications for Powder-Actuated Fasteners: Certified by fastener system manufacturer with current operator's license.
  - D. Installer Qualifications for Field-Welding: As specified in Division 05.
  - E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.1 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of electrical work.
  2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
  3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported. Include consideration for vibration, equipment operation, and shock loads where applicable.
  4. Do not use products for applications other than as permitted by NFPA 70 and product listing.
  5. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
  6. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
    - a. Indoor Dry Locations: Use zinc-plated steel or approved equivalent unless otherwise indicated.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel, stainless steel, or approved equivalent unless otherwise indicated.
    - c. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
    - d. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Materials for Metal Fabricated Supports: Comply with Division 05.
- C. Conduit and Cable Supports: Straps, clamps, etc. suitable for the conduit or cable to be supported.
1. Conduit Straps: One-hole or two-hole type; steel ~~or malleable iron~~.
  2. Conduit Clamps: Bolted type unless otherwise indicated.
  3. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation; [www.cooperindustries.com](http://www.cooperindustries.com).
    - b. Erico International Corporation; [www.erico.com](http://www.erico.com).
    - c. O-Z/Gedney, a brand of Emerson Industrial Automation; [www.emersonindustrial.com](http://www.emersonindustrial.com).
    - d. Thomas & Betts Corporation; [www.tnb.com](http://www.tnb.com).
    - e. Substitutions: See Division ~~Section 01 6000~~ - Product Requirements.

- D. Outlet Box Supports: Hangers, brackets, etc. suitable for the boxes to be supported.
1. Manufacturers:
    - a. Cooper Crouse-Hinds, a division of Eaton Corporation  
www.cooperindustries.com.
    - b. Erico International Corporation www.erico.com.
    - c. O-Z/Gedney, a brand of Emerson IndustrialAutomation;  
www.emersonindustrial.com.
    - d. Thomas & Betts Corporation: www.tnb.com.
    - e. Substitutions: See Division - Product Requirements.
- E. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
1. Comply with MFMA-4.
  2. Channel Material:
    - a. Indoor Dry Locations: Use galvanized steel.
    - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
  3. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
  4. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
  5. Manufacturers:
    - a. Cooper B-Line, a division of Eaton Corporation:  
www.cooperindustries.com.
    - b. Thomas & Betts Corporation: www.tnb.com.
    - c. Unistrut, a brand of Atkore International Inc.: www.unistrut.com.
    - d. Substitutions: See Division 01- General Requirements.
    - e. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
- F. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
1. Minimum Size, Unless Otherwise Indicated or Required:
    - a. Equipment Supports: 1/2 inch diameter.
    - b. Busway Supports: 1/2 inch diameter.
    - c. Single Conduit up to 1 inch trade size: 1/4 inch diameter.
    - d. Single Conduit larger than 1 inch trade size: 3/8 inch diameter.
    - e. Trapeze Support for Multiple Conduits: 3/8 inch diameter.
    - f. Outlet Boxes: 1/4 inch diameter.
    - g. Luminaires: 1/4 inch diameter.
- G. Penetrating Rooftop Supports for Low-Slope Roofs: Steel pedestals with thermoplastic or rubber bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
1. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
  2. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.
  3. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.

4. Manufacturers:
  - a. Cooper B-Line, a division of Eaton Corporation;  
www.cooperindustries.com.
  - b. Erico International Corporation: www.erico.com.
  - c. PHP Systems/Design: www.phpsd.com.
  - d. Unistrut, a brand of Atkore International Inc: www.unistrut.com.
  - e. Substitutions: See Division 01 - General Requirements.
  
- H. Anchors and Fasteners:
  1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
  2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
  3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
  4. Hollow Masonry: Use toggle bolts.
  5. Hollow Stud Walls: Use toggle bolts.
  6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
  7. Sheet Metal: Use sheet metal screws.
  8. Wood: Use wood screws.
  9. Plastic and lead anchors are not permitted.
  10. Powder-actuated fasteners may be used with:
    - a. Permission by Architect.
    - b. Permission by Structural Engineer.
    - c. Use only threaded studs; do not use pins.
  11. Hammer-driven anchors and fasteners are permitted as follows:
    - a. Nails are permitted for attachment of nonmetallic boxes to wood frame construction (when specified).
    - b. Staples are permitted for attachment of nonmetallic-sheathed cable to wood frame construction (when specified).
  12. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
    - a. Comply with MFMA-4.
    - b. Channel Material: Use galvanized steel.
    - c. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch minimum base metal thickness.
    - d. Manufacturer: Same as manufacturer of metal channel (strut) framing system.
  13. Manufacturers - Mechanical Anchors:
    - a. Hilti, Inc.: www.us.hilti.com.
    - b. ITW Red Head, a division of Illinois Tool Works, Inc.:  
www.itwredhead.com.
    - c. Powers Fasteners, Inc.: www.powers.com.
    - d. Simpson Strong-Tie Company Inc.: www.strongtie.com.
    - e. Substitutions: See Division 01 - General Requirements.

14. Manufacturers - Powder-Actuated Fastening Systems:
  - a. Hilti, Inc.: [www.us.hilti.com](http://www.us.hilti.com).
  - b. ITW Ramset, a division of Illinois Tool Works, Inc.: [www.ramset.com](http://www.ramset.com).
  - c. Powers Fasteners, Inc.: [www.powers.com](http://www.powers.com).
  - d. Simpson Strong-Tie Company Inc.: [www.strongtie.com](http://www.strongtie.com).
  - e. Substitutions: See Division 01 - General Requirements.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that mounting surfaces are ready to receive support and attachment components.
- C. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Provide independent support from building structure. Do not provide support from piping, ductwork, or other systems.
- D. Unless specifically indicated, do not provide support from suspended ceiling support system or ceiling grid.
- E. Unless specifically indicated, do not provide support from roof deck.
- F. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- G. Equipment Support and Attachment:
  1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
  2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
  3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
  4. Unless otherwise indicated, mount floor-mounted equipment on properly sized 4 inch high concrete pad constructed in accordance with Division 03.
  5. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- H. Conduit Support and Attachment: Also comply with Section 26 0534.



- I. Box Support and Attachment: Also comply with Section 26 0533.
  - J. Luminaire Support and Attachment: Also comply with Section 26 5100.
  - K. Preset Concrete Inserts: Use manufacturer provided closure strips to inhibit concrete seepage during concrete pour.
  - L. Secure fasteners according to manufacturer's recommended torque settings.
  - M. Remove temporary supports.
- 3.3 FIELD QUALITY CONTROL
- A. See Division 01 - General Requirements.
  - B. Inspect support and attachment components for damage and defects.
  - C. Repair cuts and abrasions in galvanized finishes using zinc-rich paint recommended by manufacturer. Replace components that exhibit signs of corrosion.
  - D. Correct deficiencies and replace damaged or defective support and attachment components.

END OF SECTION 260529

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SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
  - 1. See Division 07 – Penetration Firestopping.
  - 2. Section 26 05 03 - Equipment Wiring Connections.
  - 3. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
  - 4. Section 26 05 29 - Hangers and Supports for Electrical Systems.
  - 5. Section 26 05 53 - Identification for Electrical Systems.
  - 6. Section 26 27 26 - Wiring Devices.
  - 7. Section 26 51 00 – Lighting.
  - 8. Section 28 31 00 – Fire Detection and Alarm.

1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
  - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
  - 3. ANSI C80.5 - Aluminum Rigid Conduit - (ARC).
- B. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
  - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
  - 4. NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports.
  - 5. NEMA RN 1 - Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
  - 6. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
  - 7. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground more than 5 feet outside Foundation Wall: Provide PVC conduit.
- C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit.

- D. In or Under Slab on Grade: Provide PVC conduit with rigid steel conduit sweeps.
  - E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal or nonmetallic outlet, pull, and junction boxes.
  - F. In Slab Above Grade: Provide rigid steel conduit. Provide cast boxes.
  - G. Wet and Damp Locations: Provide rigid steel conduit. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
  - H. Wet or Damp corrosive environments: Use only building wire, Type THHN/THWN insulation, in Schedule 40 PVC conduit. Provide non-metallic WP boxes.
  - I. Concealed Dry Locations: Provide EMT conduit. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
  - J. Dry Finished Locations: Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
  - K. Exposed Dry Finished Locations: Provide surface metal raceway and fittings. Unless specified on drawings, requires design team approval for use of surface metal raceway in finished locations. Coordinate all vertical runs of surface raceway with the architect prior to installation.
- 1.4 DESIGN REQUIREMENTS
- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.
- 1.5 SUBMITTALS
- A. See Division 01 – General requirements.
  - B. Product Data: Submit for the following:
    - 1. Flexible metal conduit.
    - 2. Liquidtight flexible metal conduit.
    - 3. Nonmetallic conduit.
    - 4. EMT.
    - 5. Raceway fittings.
    - 6. Conduit bodies.
    - 7. Surface raceway.
    - 8. Wireway.
    - 9. Pull and junction boxes.
  - C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.6 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Project Record Documents:
  - 1. Record actual routing of conduits larger than 2 inch.
  - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General Requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.8 COORDINATION

- A. See Division 01 – General Requirements.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 0503.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
  - 1. Allied Tube and Conduit.
  - 2. Western Tube and Conduit.
  - 3. Wheatland Tube Company.
  - 4. Substitutions: See Division 01 – General Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Rigid Aluminum Conduit: ANSI C80.5.
- D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

2.2 FLEXIBLE METAL CONDUIT

- A. Manufacturers:
  - 1. Allied Tube and Conduit
  - 2. Western Tube and Conduit.
  - 3. Wheatland Tube Company.
  - 4. Substitutions: See Division 01 – General Requirements.

- B. Fittings: NEMA FB 1.
- 2.3 LIQUIDTIGHT FLEXIBLE METAL CONDUIT
- A. Manufacturers:
    - 1. Carlon Electrical Products.
    - 2. Anamet Electrical.
    - 3. Allied Tube and Conduit.
    - 4. Substitutions: See Division 01 – General Requirements.
  - B. Fittings: NEMA FB 1.
- 2.4 ELECTRICAL METALLIC TUBING (EMT)
- A. Manufacturers:
    - 1. Allied Tube and Conduit.
    - 2. Western Tube and Conduit.
    - 3. Wheatland Tube Company.
    - 4. Substitutions: See Division 01 – General Requirements.
  - B. Product Description: ANSI C80.3; galvanized tubing.
  - C. Fittings and Conduit Bodies: NEMA FB 1; steel, set screw type.
- 2.5 NONMETALLIC CONDUIT
- A. Manufacturers:
    - 1. Carlon Electrical Products.
    - 2. Thomas & Betts Corp.
    - 3. Allied Tube and Conduit.
    - 4. Substitutions: See Division 01- General Requirements.
  - B. Product Description: NEMA TC 2; Schedule 40/80 PVC.
  - C. Fittings and Conduit Bodies: NEMA TC 3.
- 2.6 SURFACE METAL RACEWAY
- A. Manufacturers:
    - 1. Hubbell Wiring Devices.
    - 2. Thomas & Betts Corp.
    - 3. The Wiremold Co.
    - 4. Substitutions: See Division 01 – General Requirements.
  - B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
  - C. General:
    - 1. System: Provide surface raceway systems for branch circuit and data network voice, video and other low-voltage wiring. Surface raceway system shall consist

- of raceway bases, covers, pre-divided raceway bases, dual covers, appropriate fittings and device mounting plates necessary for a complete installation.
2. Configuration: Raceways shall be one- or two-piece design with base and snap-on cover, or three-piece design with base and two snap-on covers which snap side by side on a common base. Base shall be dividable with a fixed barrier for up to 4 compartments. Raceway shall be available in widths of 3/4" to 10" and depths of 17/32" to 5" Provide raceways from a company that can provide custom sizes if required. Raceway covers shall be available in tamper-resistant form with screws on access plates and covers of fittings, but not on standard cover lengths. Raceways shall be multi-piece design with metal base and snap-on metal covers. Assembled base and cover is 5-3/4" wide by 2-1/8" high with a cross section area of 10.06 square in. Base shall have 2 wiring channels, separated by 1 integral divider, large enough to accept standard power and communication devices without restricting capacity of the adjacent channel. The raceway base shall accept 2 covers that allow separation of services. The cover shall slightly curve and form the raceway sidewall. Provide the base with scored lines to facilitate sectioning of the raceway in 4" increments and include mounting holes, and tunnel knockouts in the divider wall that will facilitate the crossing over of services.
  3. Fittings: Fittings shall include flat, internal and external elbows, couplings for joining raceway sections, wire clips, blank end fittings, and device mounting brackets and plates as applicable. Where required, provide tamper-resistant form, dividable with barriers and matching the size of the accompanying raceway base. Provide full capacity corner elbows and tee fittings to maintain a controlled 2" cable bend radius, meeting the specification for Fiber Optic and UTP cabling and exceeding the TIA/EIA-569-A requirements for communications pathways.
  4. Device Brackets and Plates: Provide in sizes to match raceway width and with mounting holes located to ensure proper mounting of devices in up to 4 compartments. Device plates shall be available in any length from 6" to 60", with cutouts to accommodate various combinations of power and communications devices in up to 4 compartments. Provide 6" and 12" long device plates with a flange to overlap the joint of adjacent cover as applicable.
  5. Communications Devices and Accessories: Raceway shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.
- D. Classification:
1. Raceway and system components shall be UL and CUL listed.
  2. Surface raceways shall be suitable for use in dry interior locations only, as covered in Article 386 (Surface Metal Raceways) 388 (Surface Nonmetallic Raceways) of the National Electrical Code.
  3. Surface metal raceways and fittings shall be listed by Underwriters Laboratories under File Number E4376, Listing and Classification Number RJBT and File Number E41751, Listing and Classification Number RJPR respectively.
  4. Systems shall comply with UL Standard UL5 for Surface Metal Raceways.
  5. Larger 2 and 3 channel non-metallic raceways shall be UL Listed under File Nos. E90378 Guide RJTX and E90377 Guide RJYT, respectively.

- E. Surface Mounted Metal Raceways: V700 One-Piece Metal Raceway, G4000 Series Multi-Channel Steel Raceway, V2100 Single-Channel Metal Raceway by The Wiremold Company or approved equal.
1. Material: Galvanized steel, minimum thickness 0.040".
  2. Finish: Factory-applied polyester topcoat applied over ivory base suitable for field-applied topcoat, color by Architect.
  3. Steel Device Brackets and Plates: Steel overlap device plate for horizontal installation of devices. Plate shall overlap cover to conceal seam.
  4. Plastic Overlapping Cover Bracket and Faceplate: Plastic device mounting bracket and trim plate for horizontal installation of devices. Plate shall overlap cover to conceal seam. Faceplate shall accept a variety of power and data/communication devices. Plastic shall be compatible with UL 94 for Plastic.
  5. Adjustable Length Raceway Couplings: Provide raceway base sections with adjustable couplings. Each pair of couplings works in conjunction with the raceway base's scored lines to allow less accurate field cuts. The coupling shall accommodate 4" of lateral movement and facilitate the ability of the raceway to maintain coordination with the wall framing as required. Each coupling shall provide a means of adding supplemental ground screws.
  6. Fittings: Fittings shall include flat, internal and external elbows, tees, entrance fittings, wire clips, cover clips, couplings, support clips, and end caps. Covers for fittings shall overlap adjoining raceway covers a minimum of 3/8". Fittings shall be color matched to the raceway. Supply fittings with a base where applicable to eliminate mitering. Provide fittings with adjustable couplings that integrate with the raceway base. Provide a take-off fitting supporting dual services to adapt to existing flush wall boxes and other series of metallic raceways. Fittings shall have provisions to accept tamper resistant fasteners to fully secure the raceway.
    - a. Fiber Optic/UTP/STP Fittings: Corner elbows, tees, and entrance end fittings as required to maintain a controlled 2" [51mm] nominal cable bend radius that meets the specifications for Fiber Optic and UTP/STP cabling and exceeds TIA 569 requirements for communications pathways.
    - b. Obstacle Avoidance and Offset Fittings: Provide fittings as required to bypass large and small obstacles and small offsets in supporting wall. Small obstacle avoidance fitting capable of being converted into a take-off fitting to transition to other metallic raceways.
  7. Device Brackets and Plates:
    - a. Forward Fittings: Provide device brackets to install single-gang devices horizontally in either channel within the raceway. Provide horizontal device brackets with a single gang face plate. Horizontal device mounting brackets shall be a single piece with integral auxiliary grounding points. Device brackets and activation face plates shall allow the electrical or communications devices to face forward from the sidewall of the raceway.
    - b. Communications Devices and Accessories: Raceway shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Provide with complete line of preprinted station and port identification labels.



- F. Multi-service in wall boxes:
1. Multi-Service In-Wall Boxes: WallSource™ Multi-Service Box by the Wiremold Company or approved equal.
    - a. Provide construction box system for bringing power and low voltage devices to one location or to back feed surface wiring systems. System shall consist of in-the-wall boxes, mounting brackets, dividers, device mounting brackets, trim rings, and device plates for a complete installation in accordance with the Drawings.
    - b. Material: 0.050" thick galvanized steel with gray or ivory suitable for field painting.
  2. Classification and Use: Provide construction box system to be utilized in dry, interior locations only as defined by Article 300-15 of the National Electrical Code, as adopted by the National Fire Protection Association and approved by the American National Standards Institute. The box and system components shall be UL listed in accordance with UL 514A and UL514C. The device mounting bracket shall be molded from color matching UL approved resin.
  3. Boxes: Each box shall include the box, dividers and mounting brackets. Dimensions of each shall be a minimum of 32 cubic inches per gang and shall be manufactured of 16-gage minimum thick steel. The box shall accommodate standard power and communication devices.
    - a. The 2-gang box shall have knockouts located on top and bottom, 2-1/4" from the face to accommodate combinations of 1/2", 3/4", and 1" trade size conduits. Boxes of 4- or 6-gangs shall have knockouts to accommodate 1-1/2" trade size conduits.
    - b. Box shall have a separate ground terminal provided in each gang.
    - c. Box shall adjust for a flush installation with the finished wall. There shall be positive stops for surface mounting to 1/2", 5/8", 1" and 1-1/4" thick wallboard. Adjusting screws shall be located outside the box for adjustment prior to installation.
  4. Device Mounting Brackets: Self-leveling device mounting bracket shall accommodate standard power devices, connectivity inserts, and Wiremold 5507 series faceplates. Mounting bracket shall be available to accommodate other manufacturer's devices. Mounting bracket shall accommodate six power devices or 18 communications inserts. All faceplates, mounting brackets and trim rings shall be color matched.
  5. Communication Devices and Accessories: Box shall accommodate a complete line of connectivity outlets and modular inserts for UTP (including Category 5, 5e, 6) STP (150 ohm) fiber optic, coaxial, and other cabling types with matching faceplates and bezels to facilitate mounting. Where indicated, provide connectivity outlets and modular inserts by Ortronics or approved equal.
  6. Fiber Optic/UTP (including Category 5, 5e, 6) Radius: The depth of the box shall accommodate a 1-1/4" cable bend radius, which meets or exceeds the specifications for fiber optic and UTP cabling and TIA/EIA-569A requirements for communications pathways. A 1" controlled radius storage loop shall be available.
  7. Device Covers: Device cover plates in the following configurations shall be available: duplex device cover plates, single 1.40" and 1.59" diameter receptacle cover plates, switch plates, GFCI cover plates, Sentrex surge receptacle cover plates and other rectangular faced plates. Single gang cover plates shall be modular in design.

- 8. Support Bracket: Provide support bracket for mounting on 16" on center studs on boxes with more than two gangs.
- 9. Dividers: Dividers shall be removable without any tools.

G. Finish: Architect to select from manufacturers standard color palette.

## 2.7 WIREWAY

- A. Manufacturers:
  - 1. Carlon Electrical Products.
  - 2. Thomas & Betts Corp.
  - 3. Hoffman.
  - 4. Substitutions: See Division 01 - Requirements.
- B. Product Description: General purpose type wireway.
- C. Knockouts: Manufacturer's standard.
- D. Cover: Screw cover.
- E. Finish: Rust inhibiting primer coating with gray enamel finish.

## 2.8 OUTLET BOXES

- A. Manufacturers:
  - 1. Erico Products.
  - 2. Raco.
  - 3. Thomas & Betts Corp.
  - 4. Substitutions: See Division 01 - Requirements.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
  - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
  - 2. Concrete Ceiling Boxes: Concrete type.
- C. Nonmetallic Outlet Boxes: NEMA OS 2.
- D. Cast Boxes: NEMA FB 1, Type FD, aluminum. Furnish gasketed cover by box manufacturer.
- E. Wall Plates for Finished Areas: As specified in Section 26 2726.
- F. Wall Plates for Unfinished Areas: Furnish gasketed cover.
- G. Provide boxes listed for "EXTRA DUTY" for exterior receptacle locations.

2.9 PULL AND JUNCTION BOXES

- A. Manufacturers:
  - 1. Carlon Electrical Products.
  - 2. Hubbell Wiring Devices.
  - 3. Thomas & Betts Corp.
  - 4. Substitutions: See Division 01 - Requirements.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Surface Mounted Cast Metal Box: NEMA 250; flat-flanged, surface mounted junction box:
  - 1. Material: Cast aluminum.
  - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.

PART 3 EXECUTION

3.1 EXAMINATION

- A. See Division 01 – General Requirements.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

3.2 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 0526.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 26 0529.
- C. Identify raceway and boxes in accordance with Section 26 0553.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 05 29.

- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 0529.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit in and under slab from point-to-point.
- K. Maintain clearance between raceway and piping for maintenance purposes.
- L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- M. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- N. Bring conduit to shoulder of fittings; fasten securely.
- O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- P. Install conduit hubs to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.
- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.
- S. Seal all raceway entering a building from the exterior with sealant identified for use with the cable insulation, shield or other cabling components.
- T. Install fittings to accommodate expansion and deflection where raceway crosses expansion joints.
- U. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- V. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- W. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.

- X. Close ends and unused openings in wireway.
- 3.4 INSTALLATION - BOXES
- A. Install wall mounted boxes at elevations to accommodate mounting heights as indicated on Drawings.
  - B. Adjust box location prior to rough-in to accommodate intended purpose.
  - C. Orient boxes to accommodate wiring devices oriented as specified in Section 26 2726.
  - D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
  - E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
  - F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
  - G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
  - H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
  - I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
  - J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
  - K. Install adjustable steel channel fasteners for hung ceiling outlet box.
  - L. Do not fasten boxes to ceiling support wires or other piping systems.
  - M. Support boxes independently of conduit.
  - N. Install gang box where more than one device is mounted together. Do not use sectional box.
  - O. Install gang box with plaster ring for single device outlets.
- 3.5 INTERFACE WITH OTHER PRODUCTS
- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07.
  - B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket. Coordinate location with roofing installation.
  - C. Locate outlet boxes to allow luminaires positioned as indicated on reflected ceiling plan.

- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- 3.6 ADJUSTING
- A. See Division 01 – General Requirements: Testing, adjusting, and balancing.
  - B. Adjust flush-mounting outlets to make front flush with finished wall material.
  - C. Install knockout closures in unused openings in boxes.
- 3.7 CLEANING
- A. See Division 01 - General Requirements.
  - B. Clean interior of boxes to remove dust, debris, and other material.
  - C. Clean exposed surfaces and restore finish.

END OF SECTION 260533

SECTION 260534 - FLOOR BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes floor boxes; floor box service fittings; poke-through fittings; and access floor boxes.
- B. Related Sections:
  - 1. See Division 07 – Penetration Firestopping.
  - 2. Section 26 0533 - Raceway and Boxes for Electrical Systems.
  - 3. Section 26 2726 - Wiring Devices: Receptacles for installation in floor boxes.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.

1.3 SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Product Data: Submit catalog data for floor boxes service fittings.
- C. Samples: Submit two of each service fitting illustrating size, material, configuration, and finish.

1.4 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Project Record Documents: Record actual locations of each floor box and poke-through fitting.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years experience.

1.6 EXTRA MATERIALS

- A. See Division 01 – General Requirements.

## PART 2 PRODUCTS

### 2.1 FLOOR BOXES

- A. Manufacturers:
  - 1. Hubbell.
  - 2. Walker.
  - 3. Leviton.
  - 4. Wiremold/Legrand.
  - 5. Substitutions: See Divisions 01 – General Requirements.
- B. Floor Boxes: NEMA OS 1, suitable for on-grade applications.
- C. Adjustability: Fully adjustable.
- D. Material: Cast metal.
- E. Style: Flush with recessed devices and mounting brackets.
- F. Shape: Rectangular.
- G. Configuration: Varies, provide with flush cover assemblies for receptacles, combination power/telecommunications or furniture feeds as indicated on drawings.

### 2.2 MULTI-SERVICE FLOOR BOX

- A. Manufacturers:
  - 1. Hubbell.
  - 2. Walker.
  - 3. Leviton.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Material: Cast-iron suitable for use on grade.
- C. Configuration: Fully adjustable with four independent wiring compartments that allow capacity for up to four duplex outlets or communications devices. Box shall permit tunneling from adjacent or opposite compartments. Box shall provide a minimum of four 1" conduit hubs and four 1 1/4" conduit hubs. Flush mount style with recessed devices.
- D. Activation Cover: Die-cast flanged cover with finish as selected by Architect.
- E. Accessories: Device mounting plates, faceplates and bezels for duplex receptacle and communications devices.
- F. Configuration: Varies, provide with flush cover assemblies for receptacles, combination power/telecommunications or furniture feeds as indicated on drawings.



### 2.3 POKE-THROUGH FITTINGS

- A. Manufacturers:
  - 1. Hubbell.
  - 2. Leviton.
  - 3. Wiremold/Legrand.
  - 4. Substitutions: See Division 01 – General Requirements.
- B. Product Description: Combination power/telecommunications assembly comprising service fittings, poke-through component, fire stops and smoke barriers, and junction box for conduit termination.
- C. Fire Rating: 2 hours.
- D. Service Fitting Type: Flush mount with recessed devices and brackets.
- E. Housing: cast aluminum.
- F. Device Plate: Finish as selected by Architect.
- G. Configuration: Varies, provide with flush cover assemblies for receptacles, combination power/telecommunications or furniture feeds as indicated on drawings.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. See Division 01 – General Requirements.
- B. Where use for a device is not specified, consult with Architect and Engineer prior to rough-in.
- C. Verify locations of floor boxes and outlets in work areas prior to rough-in.
- D. Verify openings in access floor are in proper locations.

### 3.2 INSTALLATION

- A. Refer to Floor Box Legend on drawings for types of floor boxes and poke-through fittings.
- B. Boxes and fittings are indicated on Drawings in approximate locations unless dimensioned. Adjust box location to accommodate intended purpose.
- C. Floor Box Requirements: Use cast floor boxes or stamped steel with fusion epoxy coating for installations in slab on grade; formed steel boxes are acceptable for other installations.
- D. Set floor boxes level.

- E. Install boxes and fittings to preserve fire resistance rating of slabs and other elements, using materials and methods specified in Division 07.
  - F. Install protective rings on active flush cover service fittings.
  - G. Confirm quantity of devices and cables intended for each box, and cable types before purchasing or setting devices.
- 3.3 ADJUSTING
- A. See Division 01 – General Requirements.
  - B. Adjust floor box flush with finish flooring material.
- 3.4 CLEANING
- A. See Division 01 – General Requirements.
  - B. Clean interior of boxes to remove dust, debris, and other material.

END OF SECTION 260534

SECTION 260553 IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Electrical identification requirements.
- B. Identification nameplates and labels.
- C. Wire and cable markers.
- D. Voltage markers.
- E. Underground warning tape.
- F. Floor marking tape.
- G. Warning signs and labels.

1.2 RELATED REQUIREMENTS

- A. Division 09 - Finishes.
- B. Section 26 0400 – General Conditions for Electrical Trades.
- C. All of Divisions 26, 27 & 28.

1.3 REFERENCE STANDARDS (follow the most currently adopted amended version)

- A. ANSI Z535.2 - American National Standard for Environmental and Facility Safety Signs.
- B. ANSI Z535.4 - American National Standard for Product Safety Signs and Labels.
- C. NFPA 70 - National Electrical Code.
- D. NFPA 70E - Standard for Electrical Safety in the Workplace;
- E. UL 969 - Marking and Labeling Systems.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Verify final designations for equipment, systems, and components to be identified prior to fabrication of identification products.
- B. Sequencing:
  - 1. Do not conceal items to be identified, in locations such as above suspended ceilings, until identification products have been installed.

2. Do not install identification products until final surface finishes and painting are complete.

#### 1.5 SUBMITTALS

- A. See Division 01- General Requirements
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for each product.
- C. Shop Drawings: Provide schedule of items to be identified indicating proposed designations, materials, legends, and formats.
- D. Manufacturer's Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation and installation of product.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General Requirements
- B. Accept identification products on site in original containers. Inspect for damage.
- C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

#### 1.7 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.

#### 1.8 FIELD CONDITIONS

- A. Do not install adhesive products when ambient temperature and humidity is lower than recommended by manufacturer.

### PART 2 PRODUCTS

#### 2.1 IDENTIFICATION REQUIREMENTS

- A. Identification for Equipment:
  1. Use identification nameplate to identify each piece of electrical distribution and control equipment and associated sections, compartments, and components.
    - a. Switchboards:
      - 1) Identify ampere rating.
      - 2) Identify voltage and phase.

- 3) Identify power source and circuit number. Include location when not within sight of equipment.
  - 4) Use identification nameplate to identify main overcurrent protective device.
  - 5) Use identification nameplate to identify load(s) served for each branch device, including spares and prepared spaces.
- b. Panelboards:
- 1) Identify ampere rating.
  - 2) Identify voltage and phase.
  - 3) Identify power source and circuit number. Include location when not within sight of equipment.
  - 4) Identify main overcurrent protective device. Use identification label for panelboards with a door. For power distribution panelboards without a door, use identification nameplate.
  - 5) Use typewritten circuit directory to identify load(s) served for panelboards with a door, including spares and spaces
- c. Enclosed switches, circuit breakers, and motor controllers:
- 1) Identify voltage and phase.
  - 2) Identify power source and circuit number. Include location when not within sight of equipment.
  - 3) Identify load(s) served. Include location when not within sight of equipment.
- d. Time Switches:
- 1) Identify load(s) served and associated circuits controlled. Include location.
- e. Enclosed Contactors:
- 1) Identify ampere rating.
  - 2) Identify voltage and phase.
  - 3) Identify configuration, e.g., E.O.E.H. (electrically operated, electrically held) or E.O.M.H. (electrically operated, mechanically held).
  - 4) Identify coil voltage.
  - 5) Identify load(s) and associated circuits controlled. Include location.
- f. Transfer Switches:
- 1) Identify voltage and phase.
  - 2) Identify power source and circuit number for both normal power source and standby power source. Include location when not within sight of equipment.
  - 3) Identify load(s) served. Include location when not within sight of equipment.
  - 4) Identify short circuit current rating based on the specific overcurrent protective device type and settings protecting the transfer switch.
- g. Electricity Meters:
- 1) Identify load(s) metered.

2. Service Equipment:
  - a. Use identification nameplate to identify each service disconnecting means.
  - b. For buildings or structures supplied by more than one service, or any combination of branch circuits, feeders, and services, use identification nameplate or means of identification acceptable to authority having jurisdiction at each service disconnecting means to identify all other services, feeders, and branch circuits supplying that building or structure. Verify format and descriptions with authority having jurisdiction.
3. Emergency System Equipment:
  - a. Use identification nameplate or voltage marker to identify emergency system equipment in accordance with NFPA 70.
  - b. Use identification nameplate at each piece of service equipment to identify type and location of on-site emergency power sources.
  - c. Use identification nameplate to identify emergency operating instructions for emergency system equipment.
4. Use voltage marker to identify highest voltage present for each piece of electrical equipment.
5. Use identification nameplate to identify equipment utilizing series ratings, where permitted, in accordance with NFPA 70.
6. Use identification nameplate to identify switchboards and panelboards utilizing a high leg delta system in accordance with NFPA 70.
7. Use identification nameplate to identify disconnect location for equipment with remote disconnecting means.
8. Use identification label or handwritten text using indelible marker on inside of door at each fused switch to identify required NEMA fuse class and size.
9. Use identification label or handwritten text using indelible marker on inside of door at each motor controller to identify nameplate horsepower, full load amperes, code letter, service factor, voltage, and phase of motor(s) controlled.
10. Use identification label to identify overcurrent protective devices for branch circuits serving fire alarm circuits. Identify with text "FIRE ALARM CIRCUIT".
11. Use field-painted floor markings, floor marking tape, or warning labels to identify required equipment working clearances where indicated or where required by the authority having jurisdiction.
  - a. Field-Painted Floor Markings: Alternating black and white stripes, 3 inches wide, painted in accordance with Section 09 9123 and 09 9113.
12. Available Fault Current Documentation: Use identification label to identify the available fault current and date calculations were performed at locations requiring documentation by NFPA 70, including but not limited to the following.
  - a. Service equipment.
  - b. Elevator control panels.
13. Arc Flash Hazard Warning Labels: Use warning labels to identify arc flash hazards for electrical equipment, such as switchboards, panelboards, industrial control panels, and meter socket enclosures that are likely to require examination, adjustment, servicing, or maintenance while energized.
  - a. Minimum Size: 3.5 by 5 inches.
  - b. Legend: Include orange header that reads "WARNING", followed by the word message "Arc Flash and Shock Hazard; Appropriate PPE Required;

Do not operate controls or open covers without appropriate personal protection equipment; Failure to comply may result in injury or death; Refer to NFPA 70E for minimum PPE requirements" or approved equivalent.

- c. Service Equipment: Include the following information in accordance with NFPA 70.
    - 1) Nominal system voltage.
    - 2) Available fault current.
    - 3) Clearing time of service overcurrent protective device(s).
    - 4) Date label applied.]
  - 14. Use warning signs to identify electrical hazards for entrances to all rooms and other guarded locations that contain exposed live parts operating at 600 V nominal or less with the word message "DANGER; Electrical hazard; Authorized personnel only" or approved equivalent.
  - 15. Use warning signs to identify electrical hazards for entrances to all buildings, vaults, rooms, or enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
  - 16. Use warning labels to identify electrical hazards for equipment, compartments, and enclosures containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
  - 17. Use warning labels, identification nameplates, or identification labels to identify electrical hazards for equipment where multiple power sources are present with the word message "DANGER; Hazardous voltage; Multiple power sources may be present; Disconnect all electric power including remote disconnects before servicing" or approved equivalent.
- B. Identification for Conductors and Cables:
- 1. Color Coding for Power Conductors 600 V and Less: Comply with Section 26 0519.
  - 2. Use identification nameplate or identification label to identify color code for ungrounded and grounded power conductors inside door or enclosure at each piece of feeder or branch-circuit distribution equipment when premises has feeders or branch circuits served by more than one nominal voltage system.
  - 3. Use wire and cable markers to identify circuit number or other designation indicated for power, control, and instrumentation conductors and cables at the following locations:
    - a. At each source and load connection.
    - b. Within boxes when more than one circuit is present.
    - c. Within equipment enclosures when conductors and cables enter or leave the enclosure.
    - d. In cable tray, at maximum intervals of 20 feet.
  - 4. Use wire and cable markers to identify connected grounding electrode system components for grounding electrode conductors.
  - 5. Use underground warning tape to identify direct buried cables.

- C. Identification for Raceways:
1. Use voltage markers to identify highest voltage present for accessible conduits at maximum intervals of 20 feet.
  2. Use voltage markers or color-coded bands to identify systems other than normal power system for accessible conduits at maximum intervals of 20 feet.
    - a. Color-Coded Bands: Use field-painting or vinyl color coding electrical tape to mark bands 3 inches wide.
      - 1) Color Code:
        - a) Emergency Power System: Red.
        - b) Fire Alarm System: Red.
      - 2) Field-Painting: Comply with Division 09.
      - 3) Vinyl Color Coding Electrical Tape: Comply with Section 26 0519.
  3. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify circuits enclosed for accessible conduits at wall penetrations, at floor penetrations, at roof penetrations, and at equipment terminations when source is not within sight.
  4. Use identification labels, handwritten text using indelible marker, or plastic marker tags to identify spare conduits at each end. Identify purpose and termination location.
  5. Use underground warning tape to identify underground raceways.
  6. Use voltage markers to identify highest voltage present for wireways at maximum intervals of 20 feet.
- D. Identification for Boxes:
1. Use voltage markers to identify highest voltage present.
  2. Use voltage markers or color coded boxes to identify systems other than normal power system.
    - a. Color-Coded Boxes: Field-painted in accordance with Section 09 9123 and 09 9113 per the same color code used for raceways.
      - 1) Emergency Power System: Red.
      - 2) Fire Alarm System: Red.
    - b. For exposed boxes in public areas, do not color code.
  3. Use identification labels or handwritten text using indelible marker to identify circuits enclosed.
    - a. For exposed boxes in public areas, use only identification labels.
  4. Use warning labels to identify electrical hazards for boxes containing exposed live parts or exposed conductors operating at over 600 V nominal with the word message "DANGER; HIGH VOLTAGE; KEEP OUT".
- E. Identification for Devices:
1. Identification for Communications Devices: Comply with Section 27 0553.
  2. Wiring Device and Wallplate Finishes: Comply with Section 26 0533.
  3. Factory Pre-Marked Wallplates: Comply with Section 26 0533.
  4. Use identification label to identify fire alarm system devices.
    - a. For devices concealed above suspended ceilings, provide additional identification on ceiling tile below device location.



5. Use identification label or engraved wallplate to identify serving branch circuit for all receptacles.
    - a. For receptacles in public areas or in areas as directed by Architect, provide identification on inside surface of wallplate.
  6. For automatically controlled receptacles integral to modular furniture: provide self-adhesive, pre-printed labels and decals on device face per NFPA 70; single or duplex as indicated on the drawings.
  7. Use identification label or engraved wallplate to identify load controlled for wall-mounted control devices controlling loads that are not visible from the control location and for multiple wall-mounted control devices installed at one location.
  8. Use identification label to identify receptacles protected by upstream GFI protection, where permitted.
- F. Identification for Luminaires:
1. Use permanent red dot on luminaire frame to identify luminaires connected to emergency power system.
- G. Identification for Photovoltaic Systems: Comply with Section 26 4500

## 2.2 IDENTIFICATION NAMEPLATES AND LABELS

- A. Identification Nameplates:
1. Manufacturers:
    - a. Brimar Industries, Inc.
    - b. Kolbi Pipe Marker Co.
    - c. Seton Identification Products
    - d. Substitutions: Division 01 - General Requirements.
  2. Materials:
    - a. Indoor Clean, Dry Locations: Use plastic nameplates.
    - b. Outdoor Locations: Use plastic, stainless steel, or aluminum nameplates suitable for exterior use.
  3. Plastic Nameplates: Two-layer or three-layer laminated acrylic or electrically non-conductive phenolic with beveled edges; minimum thickness of 1/16 inch; engraved text.
    - a. Exception: Provide minimum thickness of 1/8 inch when any dimension is greater than 4 inches.
  4. Stainless Steel Nameplates: Minimum thickness of 1/32 inch; engraved or laser-etched text.
  5. Aluminum Nameplates: Anodized; minimum thickness of 1/32 inch; engraved or laser-etched text.
  6. Mounting Holes for Mechanical Fasteners: Two, centered on sides for sizes up to 1 inch high; Four, located at corners for larger sizes.
- B. Identification Labels:
1. Manufacturers:
    - a. Brady Corporation.
    - b. Brother International Corporation.
    - c. Panduit Corp
    - d. Substitutions: Division 01 - General Requirements.

2. Materials: Use self-adhesive laminated plastic labels; UV, chemical, water, heat, and abrasion resistant.
    - a. Use only for indoor locations.
  3. Text: Use factory pre-printed or machine-printed text. Do not use handwritten text unless otherwise indicated.
- C. Format for Equipment Identification:
1. Minimum Size: 1 inch by 2.5 inches.
  2. Legend:
    - a. System designation where applicable:
      - 1) Emergency Power System: Identify with text "EMERGENCY".
      - 2) Fire Alarm System: Identify with text "FIRE ALARM".
    - b. Equipment designation or other approved description.
    - c. Other information as indicated.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height:
    - a. System Designation: 1 inch.
    - b. Equipment Designation: 1/2 inch.
    - c. Other Information: 1/4 inch.
    - d. Exception: Provide minimum text height of 1 inch for equipment located more than 10 feet above floor or working platform.
  5. Color:
    - a. Normal Power System: White text on black background.
    - b. Emergency Power System: White text on red background.
    - c. Fire Alarm System: White text on red background.
- D. Format for General Information and Operating Instructions:
1. Minimum Size: 1 inch by 2.5 inches.
  2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 1/4 inch.
  5. Color: Black text on white background unless otherwise indicated.
    - a. Exceptions:
      - 1) Provide white text on red background for general information or operational instructions for emergency systems.
      - 2) Provide white text on red background for general information or operational instructions for fire alarm systems.
- E. Format for Caution and Warning Messages:
1. Minimum Size: 2 inches by 4 inches.
  2. Legend: Include information or instructions indicated or as required for proper and safe operation and maintenance.
  3. Text: All capitalized unless otherwise indicated.
  4. Minimum Text Height: 1/2 inch.
  5. Color: Black text on yellow background unless otherwise indicated.

- F. Format for Receptacle Identification:
  - 1. Minimum Size: 3/8 inch by 1.5 inches.
  - 2. Legend: Power source and circuit number or other designation indicated.
    - a. Include voltage and phase for other than 120 V, single phase circuits.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch.
  - 5. Color: Black text on clear background.
  
- G. Format for Control Device Identification:
  - 1. Minimum Size: 3/8 inch by 1.5 inches.
  - 2. Legend: Load controlled or other designation indicated.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch.
  - 5. Color: Black text on clear background.
  
- H. Format for Fire Alarm Device Identification:
  - 1. Minimum Size: 3/8 inch by 1.5 inches.
  - 2. Legend: Designation indicated and device zone or address.
  - 3. Text: All capitalized unless otherwise indicated.
  - 4. Minimum Text Height: 3/16 inch.
  - 5. Color: Red text on white background.
  - 6.

## 2.3 WIRE AND CABLE MARKERS

- A. Manufacturers:
  - 1. Brady Corporation
  - 2. HellermannTyton
  - 3. Panduit Corp
  - 4. Substitutions: Division 01 - General Requirements.
  
- B. Markers for Conductors and Cables: Use wrap-around self-adhesive vinyl cloth, wrap-around self-adhesive vinyl self-laminating, heat-shrink sleeve, plastic sleeve, plastic clip-on, or vinyl split sleeve type markers suitable for the conductor or cable to be identified.
  - 1. Do not use self-adhesive type markers.
  
- C. Markers for Conductor and Cable Bundles: Use plastic marker tags secured by nylon cable ties.
  
- D. Legend: Power source and circuit number or other designation indicated.
  
- E. Text: Use factory pre-printed or machine-printed text, all capitalized unless otherwise indicated.
  - 1. Do not use handwritten text.
  
- F. Minimum Text Height: 1/8 inch.
  
- G. Color: Black text on white background unless otherwise indicated.

## 2.4 VOLTAGE MARKERS

- A. Manufacturers:
  - 1. Brady Corporation
  - 2. Brimar Industries, Inc
  - 3. Seton Identification Products
  - 4. Substitutions: Division 01 - General Requirements.
- B. Markers for Conduits: Use factory pre-printed self-adhesive vinyl, self-adhesive vinyl cloth, or vinyl snap-around type markers.
- C. Markers for Boxes and Equipment Enclosures: Use factory pre-printed self-adhesive vinyl or self-adhesive vinyl cloth type markers.
- D. Minimum Size:
  - 1. Markers for Equipment: 1 1/8 by 4 1/2 inches.
  - 2. Markers for Conduits: As recommended by manufacturer for conduit size to be identified.
  - 3. Markers for Pull Boxes: 1 1/8 by 4 1/2 inches.
  - 4. Markers for Junction Boxes: 1/2 by 2 1/4 inches.
- E. Legend:
  - 1. Markers for Voltage Identification: Highest voltage present.
  - 2. Markers for System Identification:
    - a. Emergency Power System: Text "EMERGENCY".
    - b. Other Systems: Type of service.
- F. Color: Black text on orange background unless otherwise indicated.

## 2.5 UNDERGROUND WARNING TAPE

- A. Manufacturers:
  - 1. Brady Corporation
  - 2. Brimar Industries, Inc
  - 3. Seton Identification Products
  - 4. Substitutions: Division 01 - General Requirements.
- B. Foil-backed Detectable Type Tape: 3 inches wide, with minimum thickness of 5 mil (0.1 mm), unless otherwise required for proper detection.
- C. Legend: Type of service, continuously repeated over full length of tape.
- D. Color:
  - 1. Tape for Buried Power Lines: Black text on red background.
  - 2. Tape for Buried Communication, Alarm, and Signal Lines: Black text on orange background.

## 2.6 WARNING SIGNS AND LABELS

- A. Manufacturers:
  - 1. Brimar Industries, Inc
  - 2. Clarion Safety Systems, LLC
  - 3. Seton Identification Products
  - 4. Substitutions: Division 01 - General Requirements.
  
- B. Comply with ANSI Z535.2 or ANSI Z535.4 as applicable.
  
- C. Warning Signs:
  - 1. Materials:
    - a. Indoor Dry, Clean Locations: Use factory pre-printed rigid plastic or self-adhesive vinyl signs.
    - b. Outdoor Locations: Use factory pre-printed rigid aluminum signs.
  - 2. Rigid Signs: Provide four mounting holes at corners for mechanical fasteners.
  - 3. Minimum Size: 7 by 10 inches unless otherwise indicated.
  
- D. Warning Labels:
  - 1. Materials: Use factory pre-printed or machine-printed self-adhesive polyester or self-adhesive vinyl labels; UV, chemical, water, heat, and abrasion resistant; produced using materials recognized to UL 969.
    - a. Do not use labels designed to be completed using handwritten text.
    - b. Provide polyester overlaminate to protect handwritten text.
  - 2. Machine-Printed Labels: Use thermal transfer process printing machines and accessories recommended by label manufacturer.
  - 3. Minimum Size: 2 by 4 inches unless otherwise indicated.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Clean surfaces to receive adhesive products according to manufacturer's instructions.

### 3.2 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
  
- B. Install identification products to be plainly visible for examination, adjustment, servicing, and maintenance. Unless otherwise indicated, locate products as follows:
  - 1. Surface-Mounted Equipment: Enclosure front.
  - 2. Flush-Mounted Equipment: Inside of equipment door.
  - 3. Free-Standing Equipment: Enclosure front; also enclosure rear for equipment with rear access.
  - 4. Elevated Equipment: Legible from the floor or working platform.
  - 5. Branch Devices: Adjacent to device.
  - 6. Interior Components: Legible from the point of access.
  - 7. Conduits: Legible from the floor.

8. Boxes: Outside face of cover.
  9. Conductors and Cables: Legible from the point of access.
  10. Devices: Outside face of cover.
- C. Install identification products centered, level, and parallel with lines of item being identified.
  - D. Secure nameplates to exterior surfaces of enclosures using stainless steel screws and to interior surfaces using self-adhesive backing or epoxy cement.
    1. Do not use adhesives on exterior surfaces except where substrate cannot be penetrated.
  - E. Install self-adhesive labels and markers to achieve maximum adhesion, with no bubbles or wrinkles and edges properly sealed.
  - F. Install underground warning tape above buried lines with one tape per trench at 3 inches below finished grade.
  - G. Secure rigid signs using stainless steel screws.
  - H. Mark all handwritten text, where permitted, to be neat and legible.

### 3.3 FIELD QUALITY CONTROL

- A. See Division 01 - General Requirements.
- B. Replace self-adhesive labels and markers that exhibit bubbles, wrinkles, curling or other signs of improper adhesion.

END OF SECTION 260553

## SECTION 260923 - LIGHTING CONTROL DEVICES

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
1. Contactors.
  2. Switches.
  3. Switch plates.
  4. Occupancy/Vacancy sensors.
  5. Lighting Control Relay panels.
  6. Photocells.
  7. Photocell control unit.
- B. Related Sections:
1. Section 019113 – General Commissioning Requirements and related specification sections apply.
  2. Section 017419 - Construction and Demolition Waste Management and Disposal.
  3. Section 018113 - Sustainable Design Requirements.
  4. Section 260503 - Equipment Wiring Connections: Execution requirements for electric connections specified by this section.
  5. Section 260519 – Building Wire and Cable.
  6. Section 260533 - Raceway and Boxes for Electrical Systems: Product requirements for raceway and boxes for placement by this section.
  7. Section 260553 - Identification for Electrical Systems: Product requirements for electrical identification items for placement by this section.
  8. Section 262726 - Wiring Devices: Product requirements for wiring devices for placement by this section.

#### 1.2 SYSTEM DESCRIPTION

- A. IECC/ASHRAE 90.1 compliant lighting controls to control all interior and exterior lighting:
1. Standalone lighting controls in individual spaces consisting of some combination of occupancy sensors, vacancy sensors, photocells, power packs, plug load control power packs, low voltage switches and low voltage switches with dimming capability.
  2. Networked lighting controls in individual spaces with timeclock control consisting of some combination of occupancy sensors, vacancy sensors, photocells, power packs, plug load control power packs, low voltage switches and low voltage switches with dimming capability.
  3. Lighting control relay panels to control building mounted egress lighting and site lighting. Incorporates microprocessor local and centralized control, communications modules, bus connected sensors and control stations and power supplies.

- B. Refer to lighting control details and riser diagrams on the drawings for additional information.

### 1.3 SUBMITTALS

- A. See Section 01 – General Requirements.
- B. Product Data: Submit manufacturer’s standard product data for each system component.
- C. Shop Drawings: Indicate dimensioned drawings of lighting control system components and accessories.
  - 1. One Line Diagram: Indicating system configuration indicating panels, number and type of switches or devices.
  - 2. Include typical wiring diagrams for each component.
- D. Manufacturer's Installation Instructions: Submit for each system component.
- E. Manufacturer's Certificate: Certify Products meet or exceed specified requirements.
- F. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections and evidence that the control schemes identified herein and shown on the typical lighting control details are configured and operational as specified.
  - 1. Show interconnecting signal and control wiring and interfacing devices that prove compatibility of inputs and outputs.
  - 2. For networked controls, list network protocols and provide statements from manufacturers that input and output devices meet interoperability requirements of the network protocol.
  - 3. Provide documentation addressing each room/area control scheme specified with a description of how the submitted system complies.

### 1.4 CLOSEOUT SUBMITTALS

- A. See Section 01 – General Requirements.
- B. Project Record Documents: Record the following information:
  - 1. Actual locations of components and record circuiting and switching arrangements.
  - 2. Wiring diagrams reflecting field installed conditions with identified and numbered system components and devices.
- C. Operation and Maintenance Data:
  - 1. Submit replacement parts numbers.
  - 2. Submit manufacturer’s published installation instructions and operating instructions.
  - 3. Recommended renewal parts list.



1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Installer shall be one who is experienced in performing the work of this section, and who has specialized in installation of work similar to that required for this project.
- B. Manufacturer Requirements: The manufacturer shall have a minimum of 5 years' experience manufacturing networked lighting control systems and shall provide 24/7 telephone support by qualified technicians.
- C. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, assemblies, and system controllers shall be resolved between the contractor and the system provider, as required to ensure proper system operation and maintainability.
- D. Performance Requirements: Shall provide all system components that have been manufactured, assembled, and installed to maintain performance criteria stated by manufacturer without defects, damage, or failure.
- E. Performance Testing Requirements
  - 1. Manufacturer shall 100% test all equipment prior to shipment. Sample testing is not acceptable.
- F. Code Requirements
  - 1. System Control Unit and System Field Devices shall be cULus listed and certified.
  - 2. All system components shall be FCC /IC compliant.
  - 3. All system components shall be installed in compliance with National Electrical Codes.
  - 4. Building Codes: All units shall be installed in compliance with applicable, local building codes.
  - 5. The lighting control systems shall be configured and provide all control functions necessary for compliance with IECC.

1.6 COORDINATION

- A. See Section 01 – General Requirements.
- B. Carefully review lighting control details and diagrams in the contract drawings to determine control zones, switching, dimming and override capabilities.
- C. Where details and wiring diagrams are shown as typical for spaces: coordinate control zones, daylight zones, switch locations, sensor locations with room furniture, layout and daylight fenestrations to achieve design intent.

- D. It is understood that the furniture layout and procurement will be completed in subsequent design phases and that the Owner and occupants of spaces may request reconfiguration of furniture layouts. Prior to rough-in wiring and configuration of lighting control devices, controllers and zone/scene wiring coordinate furniture layout with the Owner and approved submittals. The contractor shall make reasonable configuration changes within a space at no cost to the project.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Section 01 – General Requirements.
- B. Accept components on site in manufacturer’s packaging. Inspect for damage.
- C. Protect components by storing in manufacturer’s containers indoor protected from weather.

#### 1.8 WARRANTY

- A. See Section 01 – General Requirements.
- B. Furnish five year manufacturer warranty for components.

#### 1.9 EXTRA MATERIALS

- A. See Section 01 – General Requirements.
- B. Furnish three of each switch type.
- C. Furnish three of each occupancy/vacancy sensor type.
- D. Furnish three of each power pack type.
- E. Furnish one of each photocell type.

### PART 2 PRODUCTS

#### 2.1 LIGHTING CONTACTORS

- A. Manufacturers:
  - 1. Automatic Switch Co.
  - 2. Cutler-Hammer.
  - 3. Square D Model.
  - 4. Siemens.
  - 5. Substitutions: See Section 01 – General Requirements.
- B. Product Description: NEMA ICS 2, magnetic lighting contactor.

- C. Configuration: Electrically or mechanically held, 2 wire control, as indicated on drawings.
- D. Coil Operating Voltage: as indicated on drawings.
- E. Poles: To match circuit configuration and control function with spare poles as indicated on drawings.
- F. Contact Rating: Conductor overcurrent protection, considering derating for continuous loads.
- G. Accessories:
  - 1. Cover Mounted Pilot Devices: NEMA ICS 5, heavy-duty.
  - 2. Selector Switch: ON/OFF/AUTOMATIC function, with rotary action.
  - 3. Auxiliary Contacts: Two field convertible in addition to seal-in contact.
  - 4. Relays: NEMA ICS 2.
  - 5. Control Power Transformers: Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
- H. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.

## 2.2 LINE VOLTAGE SWITCHES

- A. Manufacturers:
  - 1. Hubbell Incorporated
  - 2. Leviton Manufacturing Co., Inc.
  - 3. Pass and Seymour/Legrand
  - 4. Substitutions: See Section 01 – General Requirements.
- B. Product Description: Specification Grade, toggle switch rated 120/277V 20A minimum.
  - 1. Material: Plastic.
  - 2. Color: By Architect.
- C. Key Switch: Spade key type. Match non-key switch ratings.

## 2.3 SWITCH PLATES

- A. Manufacturers:
  - 1. Hubbell Incorporated.
  - 2. Leviton Manufacturing Co., Inc.
  - 3. Pass and Seymour/Legrand.
  - 4. Substitutions: See Section 01 – General Requirements.
- B. Product Description: Specification Grade.
  - 1. Material: Stainless steel.

2.4 LOW VOLTAGE OCCUPANCY SENSORS

- A. Manufacturers:
  - 1. nLIGHT (basis of design)
  - 2. Douglas Controls
  - 3. Eaton
  - 4. Hubbell
  - 5. Substitutions: See Section 01 – General Requirements.
- B. Refer to drawings for additional specifications and model numbers.
- C. Coverage: 2,000 square feet.
- D. Dual technology: PIR and Ultrasound.
- E. Operation: Silent.
- F. Room Sensors: As indicated on Drawings.
- G. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 12 minutes.
- H. Furnish with power pack by same manufacturer, as noted on drawings.

2.5 LOW VOLTAGE VACANCY SENSORS

- A. Manufacturers:
  - 1. nLIGHT (basis of design)
  - 2. Douglas Controls
  - 3. Eaton
  - 4. Hubbell
  - 5. Substitutions: See Section 01 – General Requirements.
- B. Refer to drawings for additional specifications and model numbers.
- C. Coverage: 2,000 square feet.
- D. Dual technology: PIR and Ultrasound.
- E. Operation: Silent.
- F. Room Sensors: As indicated on Drawings.
- G. Separate sensitivity and time delay adjustments with LED indication of sensed movement. User adjustable time-delay: 30 seconds to 12 minutes.
- H. Furnish with power pack by same manufacturer, as noted on drawings.

- I. Furnish with low voltage, momentary contact pushbutton for manual-on control by same manufacturer.
  - J. In locations noted on drawings, furnish with low voltage 0-10V dimmer switch for both manual-on control and raise/lowering of the light levels.
- 2.6 OCCUPANCY SENSOR SWITCHES
- A. Manufacturers:
    - 1. nLIGHT (basis of design)
    - 2. Douglas Controls
    - 3. Eaton
    - 4. Lutron
    - 5. Substitutions: See Section 01 – General Requirements.
  - B. Product Description: Provide specification grade, wall switch style occupancy sensor capable of turning lights OFF when the space becomes unoccupied and ON when the space becomes re-occupied.
  - C. Sensor shall utilize dual technology, PIR and ultrasound.
  - D. Sensor shall be capable of operating with LED.
  - E. Sensor shall be line voltage @ 120 or 277 VAC, rated for 20A.
  - F. Sensor shall be capable of turning lights OFF after 30 minutes of inactivity. Switch shall also have 10 and 20 minute overrides.
  - G. Provide device capable of taking a 2-wire input (and ground).
  - H. Where indicated on drawings, occupancy sensor switch shall be wired in parallel with a 3-way toggle switch per manufacturer instruction. Occupancy sensor switch shall be capable of operating in conjunction with a 3-way switch.
  - I. Refer to lighting control details on drawings for sensor types.

2.7 VACANCY SENSOR SWITCHES

- A. Manufacturers:
  - 1. nLIGHT (basis of design)
  - 2. Douglas Controls
  - 3. Eaton
  - 4. Lutron
  - 5. Substitutions: See Section 01 – General Requirements.
- B. Product Description: Provide specification grade, wall switch style vacancy sensor capable of turning lights OFF when the space becomes unoccupied. Lighting shall turn ON via manual control only, using a push-button integral to the switch.

- C. Sensor shall utilize dual technology, PIR and ultrasound.
- D. Sensor shall be capable of operating with LED fixtures.
- E. Sensor shall be line voltage @ 120 or 277 VAC, rated for 20A.
- F. Sensor shall be capable of turning lights OFF after 30 minutes of inactivity. Switch shall also have 10 and 20 minute overrides.
- G. Refer to lighting control details on drawings for sensor types.

## 2.8 PHOTOCELLS

- A. Manufacturers:
  - 1. nLIGHT (basis of design)
  - 2. Douglas Controls
  - 3. Hubbell.
  - 4. Tork
  - 5. AMF
  - 6. LC&D
  - 7. Substitutions: See Section 01 – General Requirements.
- B. General: Consist of sensor mounted as indicated on Drawings.
- C. Sensor Devices: Each sensor employs photo diode technology to allow linear response to daylight within illuminance range.
  - 1. Exterior Lighting: Hooded sensor, horizontally mounted, employing flat lens. Entire sensor encased in optically clear epoxy resin.
  - 2. Indoor Lighting: Sensor with Fresnel lens providing for 60 degree cone shaped response area to monitor indoor lighting levels.

## 2.9 LIGHTING CONTROL RELAY PANELS

- A. Manufacturers:
  - 1. nLIGHT (basis of design)
  - 2. Substitutions: See Section 01 – General Requirements and paragraph C below.
- B. Install a lighting control system consisting of relay panel(s), control switches, and other controlling devices. The devices are connected by low voltage and line voltage wiring. The general operation of lighting and controlled loads shall include:
  - 1. Interior lighting: Manual switch and on/off with automatic time scheduled shut off.
  - 2. Scheduled on/off loads: Time on, time off by automatic time schedule with after hour override capability and shutoff.
  - 3. Time clock control: Astronomic on/time off, time on/astronomic off, photocell on/time clock off.

- C. The basis of the specified system is the ARP INTENCXX NLT lighting control relay panel manufactured by Acuity Controls nLight with field configurable relays. Any other system to be considered must be submitted in writing to the engineer for consideration. Prior approval does not guarantee final approval by the electrical engineer. The contractor shall be completely responsible for providing a system meeting this specification in its entirety. All deviations from this specification must be listed and individually signed off by the Architect and Engineer.
- D. Features:
1. Lighting control system shall be digital and consist of a relay panel with 8 individual field configurable relays, digital switches and digital interface cards. System panels shall connect in a daisy chain style and be controlled via Category 5 patch cables with RJ45 connectors, providing real-time two-way communication with each system component.
  2. Lighting Control Panels shall be UL listed under UL 916 Energy Management Equipment for normal lighting and ETL Listed to UL924 for emergency lighting and consist of the following:
    3. Enclosure/Tub: NEMA 1.
    4. Cover: Surface mount screw cover.
    5. Interior: Barrier for separation of high voltage (class 1) and low voltage (class 2) wiring and emergency wiring. It shall include digital interface boards, input boards, power supply and control relays. Clock display and keypad shall be mounted on interior cabinet door for easy user access and programming.
    6. Field configurable relays shall have normally closed/normally open latching contacts. Relays shall be UL listed 30A @ 277V and 20A @ 347V for ballast/HID and 20A tungsten @ 120V with an 18,000 SCCR @ 277V. Relays shall be rated for 250,000 operations @20A fully loaded. Relays shall be configurable for 2-pole operation.
    7. Relay panel electronics shall provide current visual status and control of each relay or zone. All system control electronics shall store programming in a non-volatile memory and provide 10 year battery backup for time of day.
    8. All switches shall communicate via nLight network using CAT 5 cable. Contact closure style switches are not acceptable. Any button or switch function shall be able to be changed locally or remotely, via modem, Ethernet or internet. Refer to details for wiring diagrams.
    9. Lighting control system interfaces to include a dry contact input interface, BMS interface, dimming system interface, Ethernet/internet interface and an interface to a smartbreaker style panelboards. Verify and install only those interfaces indicated on the plans.
    10. Where indicated, after-hour interior lighting shut off control shall provide a full duration override time of 1 to 240 minutes with a warning blink five minutes prior to shutting the lighting off. An impending shut off will be cancelled and the override period re-initialized through the operation of any assigned switch input.
    11. After-hour interior lighting shut off control may be by line voltage power interrupt control to automatic control switches. The lighting control relay panel shall provide a warning blink signal to automatic control switches, thus allowing a five-minute delay prior to shutting off lighting. The lighting shut off event may be cancelled by pressing the automatic control switch push button. The lighting

control panel time clock shall provide periodic lighting sweep signals to shut off automatic control switches/relays.

## 2.10 LOW VOLTAGE KEYPADS / SWITCHES

- A. Provide low voltage keypads / switches with configuration, functionality and operation as indicated on drawings.
- B. General Requirements:
  - 1. Custom engravable buttons/switches, refer to drawings for labeling. Refer to Paragraph C below for additional requirements.
  - 2. Quantity and function as indicated on drawings.
  - 3. LED indicators, as shown on drawings.
  - 4. Configured to fit in standard gang boxes.
  - 5. Color: By Architect
- C. Labeling:
  - 1. Provide factory engraved labels for all low voltage keypads / switches buttons.
  - 2. Refer to lighting control details on drawings for suggested labeling of lighting control equipment. Coordinate naming of scenes/control zones with the Owner. Provide a worksheet listing remote keypad controls, labeling requests and locations to the Owner for their labeling requests.
  - 3. Do not order labels until Owner coordination is complete.
- D. Lighting keypad shall be provided by the same manufacturer as the lighting control system.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Site Verification:
  - 1. Verify that wiring conditions, which have been previously installed under other sections or at a previous time, are acceptable for product installation in accordance with manufacturer's instruction.
  - 2. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
  - 3. Verify that openings for outlet boxes are neatly cut and will be completely covered by devices or wall plates.
  - 4. Verify that final surface finishes are complete, including painting.
  - 5. Verify that branch circuit wiring installation is completed, tested, and ready for connection to lighting control devices.
  - 6. Verify that the service voltage and ratings of lighting control devices are appropriate for the service voltage and load requirements at the location to be installed.
  - 7. Verify that conditions are satisfactory for installation prior to starting work.



- B. Inspection: Inspect all material included in this contract prior to installation. Manufacturer shall be notified of unacceptable material prior to installation.

### 3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### 3.3 INSTALLATION

- A. The Electrical Contractor, as part of the work of this section, shall coordinate, receive, mount, connect, and place into operation all equipment. The Electrical Contractor shall furnish all conduit, wire, connectors, hardware, and other incidental items necessary for properly functioning lighting control as described herein and shown on the plans (including but not limited to System Field Devices, 0-10V dimming ballasts, fixed output ballasts, 0-10V LED drivers and communication wire). The Electrical Contractor shall maintain performance criteria stated by manufacturer without defects, damage, or failure.
- B. Install lighting control devices in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards, unless otherwise indicated. Install per manufacturer's instructions.
- C. Power: The contractor shall test that all branch load circuits are operational before connecting loads to sensor system load terminals, and then de-energize all circuits before installation.
- D. Provide equipment at locations and in quantities indicated on Drawings. Provide any additional equipment required to provide control intent.
- E. Install wiring in accordance with Section 260519 and paragraph 2.13.
- F. Use only properly color coded, stranded wire. Install wire sizes as indicated on Drawings. Install wire in conduit in accordance with Section 260533 and paragraph 2.13.
- G. Mount relay panel as indicated on Drawings. Wire numbered relays in panel to control power to each load.
- H. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.
- I. Identify power wiring with circuit breaker number controlling load. When multiple circuit breaker panels are feeding into relay panel, label wires to indicate originating panel designation.
- J. Label each low voltage wire with relay number at each switch or sensor. Refer to Section 26 05 53.

- K. Coordinate locations of outlet boxes provided under Section 260533 as required for installation of lighting control devices provided under this section.
  - L. Orient outlet boxes for vertical installation of lighting control devices unless otherwise indicated.
  - M. Coordinate final location with Architect.
  - N. Ensure that daylight sensor placement minimizes sensors view of electric light sources; ceiling mounted and fixture-mounted daylight sensors shall not have direct view of luminaries.
  - O. Prior to setting scenes or zones dependent on furniture placement, whiteboard locations, projection screen locations, lectern locations or similar, coordinate with the Owner, Architect and red-lined furniture plans. Make all required adjustments during construction.
  - P. Systems Integration:
    - 1. Equipment Integration Meeting:
      - a. Facility Representative to coordinate meeting between Facility Representative, Lighting Control System Manufacturer and other related equipment manufacturers to discuss equipment and integration procedures prior to system startup
  - Q. Unless otherwise indicated, connect lighting control device grounding terminal or conductor to branch circuit equipment grounding conductor and to outlet box with bonding jumper.
  - R. Install lighting control devices plumb and level, and held securely in place.
  - S. Where applicable, install lighting control devices and associated wall plates to fit completely flush to mounting surface with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
  - T. Identify lighting control devices in accordance with Section 260553.
  - U. Unless otherwise indicated, install power packs/room controllers for lighting control devices within the same space above accessible ceiling or above access panel in inaccessible ceiling.
  - V. Where indicated, install separate compatible wall switches for manual control interface with lighting control devices or associated power packs.
- 3.4 SENSOR INSTALLATION:
- A. Adjust sensitivity to cover area installed

- B. Set time delay on sensors that are connect to the lighting control system to the minimum. Time delay to off shall be set to no longer than 20 minutes.
- C. Provide vacancy sensor configurations as indicated on drawings.
- D. Install sensors on vibration free stable surface.
- E. Install atrium and skylight light sensor facing toward window or skylight.
- F. Install interior light sensor in ceiling facing the floor.
- G. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize coverage and avoid conflicts or problems affecting coverage.
- H. Locations indicated are diagrammatic and only intended to indicate which rooms or areas require devices. Provide quantity and locations as required for complete coverage of respective room or area based on manufacturer's recommendations for installed devices.
- I. Locate ultrasonic and dual technology passive infrared/ultrasonic occupancy sensors away from air supply ducts or other sources of heavy air flow and as per manufacturer's recommendations, in order to minimize false triggers.
- J. Where indicated or as directed by Architect, install factory masking material or adjust integral blinders on sensor lenses to block undesired motion detection.
- K. Outdoor Photo Sensor Control Locations:
  - 1. Where possible, locate outdoor photo controls with photo sensor facing north. If north facing photo sensor is not possible, install with photo sensor facing east, west, or down.
  - 2. Locate outdoor photo controls so that photo sensors do not face artificial light sources, including light sources controlled by the photo control itself.
  - 3. Install outdoor photo controls so that connections are weatherproof. Do not install photo controls with conduit stem facing up in order to prevent infiltration of water into the photo control.
  - 4. Unless otherwise indicated, set outdoor photo sensor for dusk-to-dawn operation. Lighting shall turn on at dusk / off at dawn.
- L. Daylighting Control Photo Sensor Locations:
  - 1. Within the design intent, reasonably minor adjustments to locations may be made in order to optimize control and avoid conflicts or problems affecting proper detection of light levels.
  - 2. Unless otherwise indicated, locate photo sensors for closed loop systems to accurately measure the light level controlled at the designated task location, while minimizing the measured amount of direct light from natural or artificial sources such as windows or pendant luminaires.
  - 3. Unless otherwise indicated, locate photo sensors for open loop systems to accurately measure the level of daylight coming into the space, while minimizing the measured amount of lighting from artificial sources.
  - 4. Refer to drawings and details for maintained light level settings.

3.5 MANUFACTURER'S FIELD SERVICES

- A. Division 01 - General Requirements.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform the following field tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After installing wall stations and sensors, and after electrical circuitry has been energized, start units to confirm proper unit operation.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 3. Test occupancy sensors to verify proper operation, including time delays and ambient light thresholds where applicable. Verify optimal coverage for entire room or area. Record test results in written report to be included with submittals. Record all settings in written report for all devices.
  - 4. Test outdoor photo controls to verify proper operation, including time delays where applicable. Record test results in written report to be included with submittals. Record calibration settings for all devices and include in written report.
  - 5. Test daylighting controls to verify proper operation, including light level measurements and time delays where applicable. Record test results in written report to be included with submittals.
  - 6. Adjust relay panel settings to achieve desired operation schedule as indicated or as directed by Architect. Record settings and as-built relay panel schedules in written report, to be included with submittals.
- D. Lighting control devices will be considered defective if they do not pass tests and inspections.

3.6 FIELD QUALITY CONTROL

- A. Division 01 - General Requirements.
- B. Inspect each lighting control device for damage and defects.
- C. Correct wiring deficiencies and replace damaged or defective lighting control devices.

3.7 ADJUSTING

- A. Division 01 - General Requirements.
- B. Test contactors and switches after installation to confirm proper operation.
- C. Confirm correct loads are recorded on directory card in each panel.
- D. Adjust daylighting controls under optimum lighting conditions after all room finishes, furniture, and window treatments have been installed to achieve desired operation as

indicated or as directed by Architect. Record settings in written report to be included with submittals. Readjust controls calibrated prior to installation of final room finishes, furniture, and window treatments that do not function properly as determined by Architect.

3.8 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

3.9 COMMISSIONING

- A. Division 01 - General Requirements.

3.10 DEMONSTRATION

- A. Division 01 - General Requirements.
- B. Functional testing: Demonstrate proper operation of lighting control devices to Engineer, and correct deficiencies or make adjustments as directed. Functional testing shall not commence until all testing and reporting listed under paragraph 3.5 are complete and submitted. Functional testing shall be in accordance with IECC paragraph C408.3.1 and shall include:
  - 1. Occupancy sensor controls.
  - 2. Vacancy sensor controls.
  - 3. Relay panel controls.
  - 4. Daylight responsive controls.
- C. Training: Train Owner's personnel on operation, adjustment, programming, and maintenance of lighting control devices.
  - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
  - 2. Provide minimum of four hours of training.
  - 3. Schedule training with Owner, provide at least 7 days notice to Architect/Engineer of training date.
  - 4. Instructor: Qualified manufacturer's representative familiar with the project and with sufficient knowledge of the installed lighting control devices.

END OF SECTION 260923

Functional

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## SECTION 262413 SWITCHBOARDS

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. See Division 01 – General Requirements.

#### 1.2 RELATED REQUIREMENTS

- A. Related Documents: See Division 01 – general Requirements.
- B. The Contract Documents are complementary. Examine all Drawings and all other Sections of the Specifications for requirements therein affecting the intent of this Section.

#### 1.3 SUMMARY

- A. Section includes distribution switchboards.
- B. Related Sections:
  - 1. Section 01 91 13 – General Commissioning Requirements and related specification sections apply.
  - 2. Section 26 05 26 - Grounding and Bonding for Electrical Systems.
  - 3. Section 26 05 53 - Identification for Electrical Systems.
  - 4. Section 26 28 13 - Fuses.

#### 1.4 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
  - 1. IEEE C57.13 - Standard Requirements for Instrument Transformers.
  - 2. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. National Electrical Manufacturers Association:
  - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
  - 3. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
  - 4. NEMA PB 2 - Deadfront Distribution Switchboards.
  - 5. NEMA PB 2.1 - General Instructions for Proper Handling, Installation, Operation, and Maintenance of Deadfront Distribution Switchboards Rated 600 Volts or Less.
- C. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.5 SUBMITTALS

- A. See Division 01 – General Requirements and Section 26 0400.
- B. Shop Drawings: Indicate front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars for each phase, neutral, and ground; and switchboard instrument details.
- C. Product Data: Submit electrical characteristics including voltage, frame size and trip ratings, fault current withstand ratings, and time-current curves of equipment and components.
- D. Test Reports: Indicate results of factory production and field tests.

1.6 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Project Record Documents: Record actual locations, configurations, and ratings of switchboards and their components on single line diagrams and plan layouts.
- C. Operation and Maintenance Data: Submit spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General Requirements.
- B. Accept switchboards on site. Inspect for damage.
- C. Store in clean, dry space. Maintain factory wrapping or provide additional canvas or plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with NEMA PB 2.1. Lift only with lugs provided. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Conform to NEMA PB 2 service conditions during and after installation of switchboards.

1.10 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication.



1.11 SEQUENCING

- A. Sequence Work to avoid interferences with building finishes and installation of other products.

1.12 MAINTENANCE MATERIALS

- A. Furnish two of each key.
- B. Furnish two fuse pullers.

1.13 EXTRA MATERIALS

- A. Furnish three of each size and type of fuse installed.

PART 2 PRODUCTS

2.1 DISTRIBUTION SWITCHBOARDS

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Siemens.
  - 4. Eaton/Cutler Hammer
  - 5. Substitutions: Not permitted.
- B. Product Description: Class 2730 service rated combination main circuit breaker and current transformer enclosed switchboard with electrical ratings and configurations as indicated on Drawings.
- C. Device Mounting:
  - 1. Main Section: Individually mounted and compartmented.
- D. Bus:
  - 1. Material: Copper with tin plating. Fully rated (no reductions).
  - 2. Connections: Bolted, accessible from front for maintenance.
  - 3. Insulation: Fully insulate load side bus bars.
- E. Line and Load Terminations: Accessible from front only of switchboard, suitable for conductor materials and sizes as indicated on Drawings.
- F. Metering Compartment: Furnish metering transformer compartment for bar type current transformers. Coordinate requirements with Utility Company.
- G. Enclosure: Type 1 - General Purpose.
- H. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.

2.2 MOLDED CASE CIRCUIT BREAKER

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Siemens.
  - 4. Eaton/Cutler Hammer.
  - 5. Substitutions: Not permitted.
- B. Product Description: NEMA AB 1, molded-case circuit breaker.
- C. Field-Adjustable Trip Circuit Breaker: Circuit breakers with frame sizes 125 amperes and larger have adjustable/changeable trip units.

2.3 SOURCE QUALITY CONTROL

- A. Furnish shop inspection and testing in accordance with NEMA PB 2.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify surface is suitable for switchboard installation.

3.2 INSTALLATION

- A. Install in accordance with NEMA PB 2.1.
- B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.
- C. Install engraved plastic nameplates in accordance with Section 26 05 53.
- D. Install breaker circuit directory.
- E. Ground and bond switchboards in accordance with Section 26 05 26.

3.3 FIELD QUALITY CONTROL

- A. See Division 01 – General Requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.1.
- D. Above testing shall be documented in writing and furnished as a part of the O&M manuals, and provided to CX agent prior to closeout.

3.4 ADJUSTING

- A. See Division 01 – General Requirements.
- B. Adjust operating mechanisms for free mechanical movement.
- C. Tighten bolted bus connections.
- D. Adjust circuit breaker trip and time delay settings to values as instructed by Architect/Engineer.

3.5 SWITCHBOARD LABELLING

- A. Label in accordance with Section 26 0553.
- B. Available Fault Current Labelling:
  - 1. Switchboards used as service equipment shall include a readily identifiable label indicating the available fault current at the terminals of the switchboard.
    - a. Label shall be located such that it is clearly visible to qualified persons prior to servicing.
    - b. Label shall be in accordance with NEC paragraph 110.21.
    - c. Label shall include the date the calculation was performed.
    - d. Fault current value shall be coordinated with the Utility Company.
- C. Arc-Flash Hazard Warning:
  - 1. All Panelboards shall include a field or factory marked label to warn qualified persons of the potential arc-flash hazard.
    - a. Label shall be located such that it is clearly visible to qualified persons prior to servicing.
    - b. Label shall be in accordance with NEC paragraph 110.21.

3.6 CLEANING

- A. See Division 01 – General Requirements.
- B. Touch up scratched or marred surfaces to match original finish.

END OF SECTION 262413

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## SECTION 262416 – PANELBOARDS

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section includes distribution and branch circuit panelboards.
- B. Related Sections:
  - 1. Section 01 91 13 – General Commissioning Requirements and related specification sections apply.
  - 2. Section 26 0526 - Grounding and Bonding for Electrical Systems.
  - 3. Section 26 0553 - Identification for Electrical Systems.

#### 1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
  - 1. IEEE C62.41 - Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
- B. National Electrical Manufacturers Association:
  - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 2. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
  - 3. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
  - 4. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
  - 5. NEMA PB 1 - Panelboards.
  - 6. NEMA PB 1.1 - General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
- C. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.
- D. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.
- E. Underwriters Laboratories Inc.:
  - 1. UL 67 - Safety for Panelboards.
  - 2. UL 1283 - Electromagnetic Interference Filters.
  - 3. UL 1449 - Transient Voltage Surge Suppressors.

#### 1.3 SUBMITTALS

- A. Shop Drawings: Indicate outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes and with built type 2 surge protection (SPD).
- B. Product Data: Submit catalog data showing specified features of standard products.

- C. Main disconnect ratings (if applicable):
    - 1. Voltage and ampacity ratings of disconnect.
    - 2. Voltage, ampacity, and interrupting ratings of fuses.
  - D. Branch device ratings including:
    - 1. Voltage, ampacity, and interrupting ratings of fused branch device.
- 1.4 CLOSEOUT SUBMITTALS
- A. Project Record Documents: Record actual locations of panelboards and record actual circuiting arrangements.
  - B. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.
- 1.5 QUALIFICATIONS
- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum five years documented experience.
- 1.6 MAINTENANCE MATERIALS
- A. Furnish two of each panelboard key. Panelboards keyed alike.
  - B. Furnish 20% or minimum of three fuses of each rating and type of fuse installed.
  - C. Furnish a minimum of one spare fuse cabinet or as indicated on the drawings.

## PART 2 PRODUCTS

### 2.1 DISTRIBUTION PANELBOARDS

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Eaton/Cutler Hammer
  - 4. Substitutions: Not permitted.
- B. Product Description: NEMA PB 1, circuit breaker type panelboard.
- C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.
- D. Panelboard shall have built in integral SPD protection for 208Y 3 phase L-N=1200, L-G=1200, N-G=1200, L-L=2000 and 208Y 3 phase shall have L-N=600, L-G=600, N-G=600, L-L =1000.
- E. Minimum integrated short circuit rating: Calculated based on primary transformer available SCR.

- F. Molded Case Circuit Breakers: NEMA AB 1, circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Furnish circuit breakers UL listed as Type HACR for air conditioning equipment branch circuits.
- G. Circuit Breaker Accessories: Trip units and auxiliary switches as indicated on Drawings.
- H. Enclosure: NEMA PB 1, Type 1 cabinet box.
- I. Cabinet Front: Surface door-in-door type, fastened with concealed trim clamps, hinged door with flush lock, metal directory frame, finished in manufacturer's standard gray enamel.
- J. Provide fully rated (100%) main circuit breakers in Panelboards where indicated.

## 2.2 BRANCH CIRCUIT PANELBOARDS

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Eaton/Cutler Hammer.
  - 4. Substitutions: Not permitted.
- B. Product Description: NEMA PB1, circuit breaker type, lighting and appliance branch circuit panelboard.
- C. Panelboard Bus: Copper current carrying components, ratings as indicated on Drawings. Furnish copper ground bus in each panelboard.
- D. Minimum Integrated Short Circuit Rating: Calculated based on primary transformer available SCR and as indicated on plans.
- E. SPD Devices: Provide integral panel mounted surge protective device modules within 208/120 volt branch power panelboards where indicated on schedules.
  - 1. IEEE C62.41 surge protective device.
  - 2. 200 kA short circuit current rating.
  - 3. Minimum current rating per phase: 120 kA.
- F. Molded Case Circuit Breakers: NEMA AB 1, bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles, listed as Type SWD for lighting circuits, Type HACR for air conditioning equipment circuits, Class A ground fault interrupter circuit breakers as indicated on Drawings. Do not use tandem circuit breakers.
- G. Enclosure: NEMA PB 1, Type 1.
- H. Cabinet Box: 6 inches deep, 20 inches wide for 240 volt and less panelboards.
- I. Cabinet Front: Flush cabinet front with concealed hinge, metal directory frame, and flush lock keyed alike. Finish in manufacturer's standard gray enamel.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Install panelboards in accordance with NEMA PB 1.1.
- B. Install panelboards plumb.
- C. Install recessed panelboards flush with wall finishes.
- D. Height: 6 feet to top of panelboard; install panelboards taller than 6 feet with bottom no more than 4 inches above floor.
- E. Install filler plates for unused spaces in panelboards.
- F. Provide typed circuit directory for each branch circuit panelboard. Revise directory to reflect circuiting changes to balance phase loads.
- G. Install engraved plastic nameplates in accordance with Section 26 0553.
- H. Install labeling indicated power supply origin of source feeding panelboard in accordance with Section 26 0553.
- I. Install a permanent label indicating the panelboard or transformer where the power supply to the panel originates.
- J. Ground and bond panelboard enclosure according to Section 26 0526. Connect equipment ground bars of panels in accordance with NFPA 70.
- K. Define each lighting control circuit breaker, relay load type and assign to required zone, input and/or schedule.

#### 3.2 FIELD QUALITY CONTROL

- A. See Division 01 - General Requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform circuit breaker inspections and tests listed in NETA ATS, Section 7.6.
- D. Perform switch inspections and tests listed in NETA ATS, Section 7.5.
- E. Perform controller inspections and tests listed in NETA ATS, Section 7.16.1.
- F. Above testing shall be coordinated with and witnessed by the CX agent.
- G. Above testing shall be documented in writing and furnished as a part of O&M manuals.



3.3 ADJUSTING

- A. See Division 01 - General Requirements.
- B. Measure steady state load currents at each panelboard feeder; rearrange circuits in panelboard to balance phase loads to within 20 percent of each other. Maintain proper phasing for multi-wire branch circuits.

END OF SECTION 262416

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SECTION 262653 ELECTRIC VEHICLE CHARGING EQUIPMENT

PART 1 GENERAL

1.1 GENERAL PROVISIONS

- A. Attention is directed to the CONTRACT AND GENERAL CONDITIONS and all Sections with DIVISION 1 - GENERAL REQUIREMENTS, which are hereby made a part of this Section of the Specifications.
- B. Attention is directed Section 26 0400 – GENERAL CONDITIONS FOR ELECTRICAL TRADES, which is hereby made a part of this Section of the Specifications.

1.2 SUMMARY

- A. Section includes EV charging equipment that provides Level 2 EV charging.
- B. Section includes Transportable, solar powered EV stations provided under Supplemental Bid 03.

1.3 REFERENCES

- A. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.
- B. Definitions
  - 1. EV: Electric vehicle.
  - 2. EV Cable: The off-board cable containing the conductor(s) to connect the EV power controller to the EV that provides both power and communications during energy transfer.
  - 3. EV Capable: Parking spaces that include nearby termination of raceway (conduit) to a power source with sufficient electrical panel capacity designed for simultaneous charging of electric vehicles in all planned EV parking spaces. Electrical wiring need not be pulled through raceway (conduit) until charging station is installed.
  - 4. EV Charger or EV Charging Equipment: See "EVSE".
  - 5. EV Connector: A conductive device that, when electrically coupled to an EV inlet, establishes an electrical connection to the EV for the purpose of power transfer and information exchange. This device is part of the EV coupler.
  - 6. EV Coupler: A mating EV inlet and connector set.
  - 7. EV Inlet: The device in the vehicle into which the EV connector is inserted, and a conductive connection is made for the transfer of power and communication. This device is part of the EV coupler.
  - 8. EV Make Ready: Parking spaces that include nearby termination of raceway (conduit) and electrical wiring pulled to a power source with sufficient electrical panel capacity for simultaneous charging of electric vehicles in all EV parking spaces.

9. EVSE: Electric Vehicle Supply Equipment. It includes the EV charging equipment and conductors, including the ungrounded, grounded, and equipment grounding conductors and EV cables, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for transferring energy between the premise wiring and the EV.

#### 1.4 SYSTEM DESCRIPTION

- A. Furnish and install permanent electric vehicle charging equipment capable of supporting the following functions:
  1. Level 2 EV charging
  2. Be networked or internet addressable and capable of participating in a demand response program or time-of-use pricing to encourage off-peak charging.
- B. Supplemental Bid 03: provide a unit cost to furnish and install transportable, solar powered EV charging stations.
- C. Ensure that all locations of EV charging equipment is capable of receiving a CDMA or GSM cellular signal. The electrical contractor is responsible for this verification prior to purchasing or installing equipment.
- D. Provide the services of a manufacturer's technician to start and verify proper installation of all equipment.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of product.
  1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for EV charging equipment.
  2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Sustainable Design Submittals:
  1. Plan showing location and number of EV charging units, and distance from building.
  2. Plan showing "reasonable accessibility" to EV charging units.
  3. Plan showing location and number of EV charging units, charging levels and connectors, and ability of EV charging units to participate in a demand-response or time-of-use pricing program, as well as a power load management system that allows for an increased number of charging stations than would otherwise be feasible without power load management.
- C. Shop Drawings: For EV charging equipment.
  1. Include plans, elevations, sections, and mounting details.
  2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  3. Detail fabrication and assembly of mounting assemblies for EV charging equipment.

- 4. Include diagrams for power, signal, and control wiring.
  - 5. Include verification of wireless communications service at each location of EV charging equipment.
- D. Coordination Drawings: Area plans and details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
- 1. Structural members to which equipment will be attached.
  - 2. Electrical service.
  - 3. Communications service, including wireless communications equipment.
- E. Qualification Data: For Installer and factory-authorized service representative.
- F. Field quality-control reports.
- G. Sample Warranty: For manufacturer's warranty.
- 1.6 CLOSEOUT SUBMITTALS
- A. See Division 01 – General requirements.
  - B. Operation and Maintenance Data: For EV charging equipment to include in operation and maintenance manuals.
  - C. Software and Firmware Operational Documentation:
    - 1. Online training and help documentation.
    - 2. Station activation sticker.
- 1.7 QUALIFICATIONS
- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
  - B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  - C. Comply with UL 2231-1, UL 2231-2, UL 2594, and NEC Article 625.
  - D. Comply with SAE J1772.
  - E. Comply with FCC Part 15 Class A.
- 1.8 PRE-INSTALLATION MEETINGS
- A. See Division 01 – General requirements.
  - B. Convene minimum one week prior to commencing work of this section.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General requirements.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.
- D. Do not deliver items to project before time of installation. Limit shipment of bulk and multiple-use materials to quantities needed for immediate installation.

1.10 COORDINATION

- A. See Division 01 – General requirements.
- B. Coordinate exact location of charging equipment on site with concrete bases provided by Division 03 concrete contractor.
- C. Coordinate bolt pattern of bollard mounted charging stations with supports provided by Division 03 concrete contractor.
- D. Wireless Survey: Complete wireless survey to determine if wireless provider signals meet or exceed manufacturer's recommended minimum values.

1.11 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace components of EV charging units that fail(s) in materials or workmanship within specified warranty period.
  - 1. Standard Warranty Period: One year from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS – PERMANENT EV CHARGING STATIONS

- A. Basis of Design: ChargePoint CT4000 series
- B. Acceptable Alternates: Eaton, Schneider Electric
- C. Substitutions – See Division 01 – General requirements.
- D. Source Limitations: Obtain EV charging equipment from single manufacturer.

2.2 MANUFACTURERS – TRANSPORTABLE, SOLAR POWERED EV CHARGING STATIONS

- A. Basis of Design: Envision Solar – EV ARC series.
- B. Substitutions – See Division 01 – General requirements.
- C. Source Limitations: Obtain EV charging equipment from single manufacturer.

2.3 PERMANENT EV CHARGING EQUIPMENT DESCRIPTION

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- B. Comply with NFPA 70.
- C. ADA compliant.
- D. Metering: +/- 2 percent from 2 percent to full scale of output (30 A).
- E. EV Charging Equipment Mounting: Bollard Mount.
- F. Enclosures:
  - 1. Rated for environmental conditions at installed location.
    - a. Outdoor Locations: NEMA 250, Type 3R.
    - b. Aluminum and UV-resistant plastic.
    - c. Paint and Anodized.
    - d. Charging components protected by security screws.
    - e. Charging connectors in locking holsters.
    - f. Meter, modem, and CPU, tamper resistant.
- G. EV Cable and Connectors:
  - 1. SAE J1772 connector.
  - 2. Locking holster.
  - 3. 18-foot cable with cable management system.
- H. Status Indicators:
  - 1. LEDs to indicate power, vehicle charging, charging complete, system status, faults, and service, as well as authorization.
- I. Display Screen:
  - 1. VGA-resolution, daylight-viewable LCD screen with UV protection. Daylight readable and fingerprint resistant.
  - 2. Displays power, charging, charging complete, remote control, system status, faults, payment and pricing details, and service.
- J. Networking:
  - 1. WAN Communications: Cellular GSM/GPRS and CDMA.
  - 2. LAN Communications: 2.4 GHz Wi-Fi 802.11b/g/n.

- 3. Capable of remote configuration, diagnostics and reporting.
- 4. Capable of remote software updates (future proof).
  
- K. Payment System:
  - 1. RFID (ISO 15693, ISO 14443), NFC, Contactless credit card reader.
  - 2. PCI (Payment Card Industry) compliant.
  - 3. Capable of remote control and authorization including mobile phone application or toll free phone number.
  
- L. Charging Network: Compatible with the ChargePoint EV charging network.
  - 1. Multiple units shall independently connect to charging network.
  - 2. Multiple units shall have one unit designated as a master unit that is configured as a gateway unit between the EV charging equipment and the charging network.
  - 3. Individual units shall be capable of indicating station status and availability providing or connecting user to customer support and remote control.

#### 2.4 PERMANENT EV CHARGING EQUIPMENT PERFORMANCE REQUIREMENTS

- A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  
- B. Surge Withstand: 6 kV at 3000 A.
  
- C. Integral GFCI.
  
- D. Auto-GFCI fault retry.
  
- E. Input Power:
  - 1. As specified on drawings.
  - 2. Dual circuits do not need to be interlocked.
  
- F. EV Charging Levels:
  - 1. Single vehicle: AC Level 2 at up to 7.2 kW (CT4000) or up to 7.7 kW (CPF25) per vehicle.
  - 2. Dual vehicles, AC Level 2 at up to 7.2 kW (CT4000) or up to 7.7 kW (CPF25) per vehicle.
  
- G. Multiple vehicles simultaneously charging at a site using Automatic Power Load Management may be charged up to 7.2 kW.

#### 2.5 TRANSPORTABLE, SOLAR POWERED EV CHARGING EQUIPMENT DESCRIPTION – SUPPLEMENTAL BID 03

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
  
- B. 16 ft. x 9 ft. PV module array using 4.3 kW panels.
  - 1. 20.5 ft. by 10.5 ft. canopy dimensions.
  - 2. 7.5 ft. minimum clearance.



- C. Ballasted Pad: 18 ft. by 7.5 ft. base footprint.
- D. Weight: less than 10,000 lbs.
- E. Surface Loading: 6 psi.
- F. Operating Temperature: -4° to 122° F.
- G. Charger Circuit: (1) with J1772 connector.
- H. Electrical:
  - 1. Total battery storage: 32 kWh
  - 2. Total EV Charger power: 4.2 kW
- I. Major Component Ratings:
  - 1. Battery: UL 94 V-O.
  - 2. Inverter and Charge Controller: UL 1741.
  - 3. Inverter: UL 1778 Annex FF.
  - 4. Solar Panels: UL 1703, IEC 61215, IEC 61730.
  - 5. EVSE: UL 2594, UL 2231.

## 2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. See Division 01 – General requirements.
- B. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- C. Examine roughing-in for EV charging equipment electrical conduit to verify actual locations of conduit connections before equipment installation.
- D. Examine walls, floors, and pavement for suitable conditions where EV charging equipment will be installed.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION – PEMAANT EV CHARGING EQUIPMENT

- A. Comply with NECA 1 and NECA 413.
- B. Concrete Base Mounting:
  - 1. Install EV charging equipment on 6-inch (150-mm) nominal-thickness concrete base. Base should be 24-inch (600 mm) diameter or square (minimum 12-inch (300 mm) from the center located conduit stub-up). Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete".
    - a. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of concrete base.
    - b. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
    - c. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
    - d. Install anchor bolts to elevations required for proper attachment to supported equipment.
    - e. Secure EV charging equipment to concrete base according to manufacturer's written instructions.
- C. Bollard Mounting:
  - 1. Allow a minimum of 24 inches (600 mm) of clearance around EV charging equipment.
  - 2. EV charging equipment receptacles or holders shall be not less than 24 inches (600 mm) and not more than 4 feet (1.2 m) above finished grade.
  - 3. Mount EV charging equipment plumb and rigid without distortion of enclosure.
  - 4. Secure EV charging equipment according to manufacturer's written instructions.
- D. Wiring Method: Install cables in raceways and cable trays. Conceal raceway and cables except in unfinished spaces.
  - 1. Comply with requirements for raceways and boxes specified in Section 260533 "Raceways and Boxes for Electrical Systems."
- E. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- F. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- G. Circuit Breakers: Comply with Section 262816 "Enclosed Switches and Circuit Breakers."
- H. Secure covers to enclosure.

3.3 CONNECTIONS

- A. Connect wiring according to Section 260519 "Electrical Power Conductors and Cable."
- B. Comply with grounding requirements in Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Comply with requirements for installation of conduit in Section 260533 "Raceways and Boxes for Electrical Systems." Drawings indicate general arrangement of conduit, fittings, and specialties.
- D. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

3.4 INSTALLATION – TRANSPORTABLE, SOLAR POWERED EV CHARGING EQUIPMENT

- A. Set in place, configure and test.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections with the assistance of a factory-authorized service representative.
- C. Tests and Inspections:
  - 1. For each unit of EV charging equipment, perform the following tests and inspections:
    - a. Unit self-test.
    - b. Operation test with load bank.
    - c. Operation test with EV.
    - d. Network communications test.
- D. EV charging equipment will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.7 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.

3.8 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for the duration of an active ChargePoint Network Service Plan.
- B. Upgrade Service: At Substantial Completion, remotely update software to latest version. Install and program software upgrades that become available while an active ChargePoint Network Service Plan is maintained. Upgrading software shall include operating system and new or revised licenses for using software.

3.9 TRAINING:

- A. The Owner may assign personnel to participate with the contractor during installation. Without delaying the work, familiarize the Owner's personnel with the installation, equipment, and maintenance.
- B. Provide training to personnel selected by the Owner on operation and basic maintenance of all systems and equipment.
- C. Include **4 hours** of training Owner's staff.

END OF SECTION 262653

SECTION 262726 WIRING DEVICES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Wall switches.
- B. Wall dimmers.
- C. Fan speed controllers.
- D. Receptacles.
- E. Wall plates.

1.2 RELATED REQUIREMENTS

- A. Section 26 0519 - Electrical Power Conductors and Cables.
- B. Section 26 0526 - Grounding and Bonding for Electrical Systems.
- C. Section 26 0503 – Equipment Wiring Connections.
- D. Section 26 0533 – Raceways and Boxes for Electrical Systems.
- E. Section 26 0553 - Identification for Electrical Systems.
- F. Section 26 0923 - Lighting Control Devices.
- G. Section 26 2913 - Enclosed Controllers.

1.3 REFERENCE STANDARDS

- A. FS W-C-596 - Connector, Electrical, Power, General Specification for; Revision H.
- B. FS W-S-896 - Switches, Toggle (Toggle and Lock), Flush-mounted (General Specification); Revision G.
- C. NECA 1 - Standard for Good Workmanship in Electrical Construction.
- D. NECA 130 - Standard for Installing and Maintaining Wiring Devices.
- E. NEMA WD 1 - General Color Requirements for Wiring Devices.
- F. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

- G. UL 20 - General-Use Snap Switches; Current Edition, Including All Revisions.
- H. UL 498 - Attachment Plugs and Receptacles; Current Edition, Including All Revisions.
- I. UL 514D - Cover Plates for Flush-Mounted Wiring Devices; Current Edition, Including All Revisions.
- J. UL 943 - Ground-Fault Circuit-Interrupters; Current Edition, Including All Revisions.
- K. UL 1310 - Class 2 Power Units; Current Edition, Including All Revisions.
- L. UL 1449 - Standard for Surge Protective Devices; Current Edition, Including All Revisions.
- M. UL 1472 - Solid-State Dimming Controls; Current Edition, Including All Revisions.
- N. UL 1917 - Solid-State Fan Speed Controls; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate the placement of outlet boxes with millwork, furniture, equipment, etc. installed under other sections or by others.
  - 2. Coordinate wiring device ratings and configurations with the electrical requirements of actual equipment to be installed.
  - 3. Coordinate the placement of outlet boxes for wall switches with actual installed door swings.
  - 4. Coordinate the installation and preparation of uneven surfaces, such as split face block, to provide suitable surface for installation of wiring devices.
  - 5. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.
- B. Sequencing:
  - 1. Do not install wiring devices until final surface finishes and painting are complete.

#### 1.5 SUBMITTALS

- A. See Division 01 - General Requirements.
- B. Product Data: Provide manufacturer's catalog information showing dimensions, colors, and configurations.
  - 1. Wall Dimmers: Include derating information for ganged multiple devices.
  - 2. Surge Protection Receptacles: Include surge current rating, voltage protection rating (VPR) for each protection mode, and diagnostics information.
- C. Samples: One for each type and color of device and wall plate specified.
- D. Certificates for Surge Protection Receptacles: Manufacturer's documentation of listing for compliance with UL 1449.

- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.
- F. Operation and Maintenance Data:
  - 1. Wall Dimmers: Include information on operation and setting of presets.
  - 2. GFCI Receptacles: Include information on status indicators.
  - 3. Surge Protection Receptacles: Include information on status indicators.
- G. Project Record Documents: Record actual installed locations of wiring devices.
- H. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Division 01 - General Requirements.
  - 2. Screwdrivers for Tamper-Resistant Screws: Two for each type of screw.
  - 3. Extra Keys for Locking Switches: Two of each type.
  - 4. Extra Surge Protection Receptacles: Two of each type.
  - 5. Extra Wall Plates: One of each style, size, and finish.

#### 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Products: Listed, classified, and labeled as suitable for the purpose intended.
- E. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### 1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Store in a clean, dry space in original manufacturer's packaging until ready for installation.

## PART 2 PRODUCTS

### 2.1 WIRING DEVICE APPLICATIONS

- A. Provide wiring devices suitable for intended use and with ratings adequate for load served.
- B. For single receptacles installed on an individual branch circuit, provide receptacle with ampere rating not less than that of the branch circuit.
- C. Provide weather resistant GFCI receptacles with specified weatherproof covers for receptacles installed outdoors or in damp or wet locations.
- D. Provide tamper resistant receptacles for receptacles where indicated on the drawings..
- E. Provide GFCI protection for receptacles installed within 6 feet of water source.
- F. Provide GFCI protection in other than dwelling units for all single-phase receptacles rated 150 volts to ground or less and all three-phase receptacles rated 150 volts to ground or less, 100 amperes or less in: Bathrooms, Kitchens and on Rooftops
- G. Provide GFCI protection for receptacles serving electric drinking fountains.
- H. Unless noted otherwise, do not use combination switch/receptacle devices.

### 2.2 WALL SWITCHES

- A. Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell-wiring.com](http://www.hubbell-wiring.com).
  - 2. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Wall Switches - General Requirements: AC only, quiet operating, general-use snap switches with silver alloy contacts, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 20 and where applicable, FS W-S-896; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring and screw actuated binding clamp for back wiring with separate ground terminal screw.
  - 2. Body and Handle finish: Color selection by Architect.
- C. Standard Wall Switches: Industrial specification grade, 20 A, 120/277 V with standard toggle type switch actuator and maintained contacts; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.



- D. Lighted Wall Switches: Industrial specification grade, 20 A, 120/277 V with illuminated standard toggle type switch actuator and maintained contacts; illuminated with load off; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- E. Pilot Light Wall Switches: Industrial specification grade, 20 A, 120/277 V with red illuminated standard toggle type switch actuator and maintained contacts; illuminated with load on; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- F. Locking Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed switch actuator and maintained contacts; switches keyed alike; single pole single throw, double pole single throw, three way, or four way as indicated on the drawings.
- G. Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with toggle type three position switch actuator and momentary contacts; single pole double throw, off with switch actuator in center position.
- H. Locking Momentary Contact Wall Switches: Industrial specification grade, 20 A, 120/277 V with lever type keyed three position switch actuator and momentary contacts; switches keyed alike; single pole double throw, off with switch actuator in center position.

### 2.3 WALL DIMMERS

- A. Manufacturers:
  - 1. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  - 2. Lutron Electronics Company, Inc; Maestro Series: [www.lutron.com/sle](http://www.lutron.com/sle).
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Wall Dimmers - General Requirements: Solid-state with continuous full-range even control following square law dimming curve, integral radio frequency interference filtering, power failure preset memory, air gap switch accessible without removing wall plate, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1472; types and ratings suitable for load controlled as indicated on the drawings.
  - 1. Body and Control finish: Color selection by Architect.
- C. Control: Slide control type with separate on/off switch.
- D. Power Rating, Unless Otherwise Indicated or Required to Control the Load Indicated on the Drawings:
  - 1. Incandescent: 600 W.
  - 2. Magnetic Low-Voltage: 600 VA.
  - 3. Electronic Low-Voltage: 400 VA.
  - 4. Fluorescent: 600 VA.

- E. Provide locator light, illuminated with load off.
- F. Provide accessory wall switches to match dimmer appearance when installed adjacent to each other.

## 2.4 FAN SPEED CONTROLLERS

- A. Manufacturers:
  - 1. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  - 2. Lutron Electronics Company, Inc; Maestro Series: [www.lutron.com/sle](http://www.lutron.com/sle).
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
  - 4. Substitutions: See Division 01 - General Requirements
- B. Description: 120 V AC, solid-state, full-range variable speed, slide control type with separate on/off switch, with integral radio frequency interference filtering, fan noise elimination circuitry, power failure preset memory, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 1917.
  - 1. Current Rating: 1.5 A unless otherwise indicated or required to control the load indicated on the drawings.

## 2.5 RECEPTACLES

- A. Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell-wiring.com](http://www.hubbell-wiring.com).
  - 2. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
  - 4. Substitutions: See Division 01 - General Requirements.
  - 5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Receptacles - General Requirements: Self-grounding, complying with NEMA WD 1 and NEMA WD 6, and listed as complying with UL 498, and where applicable, FS W-C-596; types as indicated on the drawings.
  - 1. Wiring Provisions: Terminal screws for side wiring or screw actuated binding clamp for back wiring with separate ground terminal screw.
  - 2. NEMA configurations specified are according to NEMA WD 6.
  - 3. Hospital Grade Receptacles: Listed as complying with UL 498 Supplement SD, with green dot hospital grade mark on device face.
  - 4. Body color:
    - a. General Purpose Receptacles: color by Architect.
    - b. Emergency receptacles: Red.
    - c. Automatically controlled receptacles: Green.
- C. Convenience Receptacles:
  - 1. Standard Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; single or duplex as indicated on the drawings.
  - 2. Isolated Ground Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, with ground contacts isolated from mounting strap;

- isolated ground triangle mark on device face; single or duplex as indicated on the drawings.
3. Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
  4. Tamper Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; single or duplex as indicated on the drawings.
  5. Tamper Resistant and Weather Resistant Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations; single or duplex as indicated on the drawings.
  6. Illuminated Convenience Receptacles: Hospital grade, 20A, 125V, NEMA 5-20R; illuminated face or indicator light to indicate power is being supplied to receptacle; single or duplex as indicated on the drawings.
- D. GFCI Receptacles:
1. GFCI Receptacles - General Requirements: Self-testing, with feed-through protection and light to indicate ground fault tripped condition and loss of protection; listed as complying with UL 943, class A.
    - a. Provide test and reset buttons of same color as device.
  2. Standard GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
  3. Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
  4. Tamper Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type.
  5. Tamper Resistant and Weather Resistant GFCI Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style, listed and labeled as tamper resistant type and as weather resistant type complying with UL 498 Supplement SE suitable for installation in damp or wet locations.
- E. Automatically Controlled Convenience Receptacles: Industrial specification grade, 20A, 125V, NEMA 5-20R; controlled receptacle marking and label on device face per NFPA 70; single or duplex as indicated on the drawings.
- F. USB Charging Devices:
1. USB Charging Devices - General Requirements: Listed as complying with UL 1310.
    - a. Charging Capacity - Two-Port Devices: 2.1 A, minimum.
    - b. Charging Capacity - Four-Port Devices: 4.2 A, minimum.
  2. USB Charging/Tamper Resistant Receptacle Combination Devices: Two-port USB charging device and receptacle, commercial specification grade, duplex,

- 20A, 125V, NEMA 5-20R, listed and labeled as tamper resistant type; rectangular decorator style.
- 3. USB Charging Non-combination Devices: Four-port; rectangular decorator style.
- G. Surge Protection Receptacles:
  - 1. Surge Protection Receptacles - General Requirements: Listed and labeled as complying with UL 1449, Type 2 or 3.
    - a. Energy Dissipation: Not less than 240 J per mode.
    - b. Protected Modes: L-N, L-G, N-G.
    - c. UL 1449 Voltage Protection Rating (VPR): Not more than 700 V for L-N, L-G modes and 1200 V for N-G mode.
    - d. Diagnostics:
      - 1) Visual Notification: Provide indicator light to report functional status of surge protection.
      - 2) Audible Notification: Provide switchable audible alarm to report that surge protection is not functional.
  - 2. Standard Surge Protection Receptacles: Industrial specification grade, duplex, 20A, 125V, NEMA 5-20R, rectangular decorator style.
- H. Locking Receptacles: Industrial specification grade, configuration as indicated on the drawings.
  - 1. Standard Locking Convenience Receptacles: Single, 20A, 125V, NEMA L5-20R.
  - 2. Special Purpose Locking Receptacles: refer to drawings and schedules for NEMA locking configuration.
- I. Clock Hanger Receptacles: Single, 15A, 125V, NEMA 5-15R.

## 2.6 WALL PLATES

- A. Manufacturers:
  - 1. Hubbell Incorporated: [www.hubbell-wiring.com](http://www.hubbell-wiring.com).
  - 2. Leviton Manufacturing Company, Inc: [www.leviton.com](http://www.leviton.com).
  - 3. Pass & Seymour, a brand of Legrand North America, Inc: [www.legrand.us](http://www.legrand.us)
  - 4. Substitutions: See Division 01 - General Requirements.
  - 5. Source Limitations: Where wall controls are furnished as part of lighting control system, provide accessory matching receptacles and wallplates by the same manufacturer in locations indicated.
- B. Wall Plates: Comply with UL 514D.
  - 1. Configuration: One piece cover as required for quantity and types of corresponding wiring devices.
  - 2. Screws: Metal with slotted heads finished to match wall plate finish.
  - 3. Provide screwless wallplates with concealed mounting hardware where indicated.

- C. Nylon Wall Plates: Smooth finish, high-impact thermoplastic.
  - 1. Wall Plate Color: color by Architect.
- D. Stainless Steel Wall Plates: Brushed satin finish, Type 302 stainless steel.
- E. Chrome Wall Plates: Smooth finish, chrome plated steel.
- F. Galvanized Steel Wall Plates: Rounded corners and edges, with corrosion resistant screws.
- G. Premarked Wall Plates: Factory labeled as indicated; hot stamped for nylon wall plates and engraved for metal wall plates.
- H. Weatherproof Covers for Damp Locations: Gasketed, cast aluminum, with self-closing hinged cover and corrosion-resistant screws; listed as suitable for use in wet locations with cover closed.
- I. Weatherproof Covers for Wet Locations: Gasketed, cast aluminum, with hinged lockable cover and corrosion-resistant screws; listed as suitable for use in wet locations while in use with attachment plugs connected and identified as extra-duty type.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate devices and conductors in accordance with NFPA 70.
- C. Verify that wall openings are neatly cut and will be completely covered by wall plates.
- D. Verify that final surface finishes are complete, including painting.
- E. Verify that floor boxes are adjusted properly.
- F. Verify that branch circuit wiring installation is completed, tested, and ready for connection to wiring devices.
- G. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

### 3.3 INSTALLATION

- A. Perform work in accordance with NECA 1 (general workmanship) and, where applicable, NECA 130, including mounting heights specified in those standards unless otherwise indicated.
- B. Coordinate locations of outlet boxes provided under Section 26 0533 as required for installation of wiring devices provided under this section.
  - 1. Mounting Heights: Unless otherwise indicated, as follows:
    - a. Wall Switches: 48 inches above finished floor.
    - b. Wall Dimmers: 48 inches above finished floor.
    - c. Fan Speed Controllers: 48 inches above finished floor.
    - d. Receptacles: 18 inches above finished floor or 6 inches above counter.
      - 1) Install convenience GFCI type receptacles 36 to 48 inches above roof deck.
      - 2) Or at designated heights as indicated on drawings.
  - 2. Orient outlet boxes for vertical installation of wiring devices unless otherwise indicated.
  - 3. Where multiple receptacles, wall switches, or wall dimmers are installed at the same location and at the same mounting height, gang devices together under a common wall plate.
  - 4. Locate wall switches on strike side of door with edge of wall plate 3 inches from edge of door frame. Where locations are indicated otherwise, notify Architect to obtain direction prior to proceeding with work.
  - 5. Locate receptacles for electric drinking fountains concealed behind drinking fountain according to manufacturer's instructions.
- C. Install wiring devices in special application enclosures per manufacturer's instructions, provide stainless steel cover plates.
- D. Install wiring devices in accordance with manufacturer's instructions.
- E. Install permanent barrier between ganged wiring devices when voltage between adjacent devices exceeds 300 V.
- F. Where required, connect wiring devices using pigtails not less than 6 inches long. Do not connect more than one conductor to wiring device terminals.
- G. Connect wiring devices by wrapping conductor clockwise 3/4 turn around screw terminal and tightening to proper torque specified by the manufacturer. Where present, do not use push-in pressure terminals that do not rely on screw-actuated binding.
- H. Unless otherwise indicated, connect wiring device grounding terminal to branch circuit equipment grounding conductor and to outlet box with bonding jumper. When stranded conductors are used in lieu of solid, use insulated crimp on fork terminals for device terminations. Do not place bare stranded conductors directly under screw terminals.

- I. For isolated ground receptacles, connect wiring device grounding terminal only to identified branch circuit isolated equipment grounding conductor. Do not connect grounding terminal to outlet box or normal branch circuit equipment grounding conductor.
  - J. Provide GFCI receptacles with integral GFCI protection at each location indicated. Do not use feed-through wiring to protect downstream devices.
  - K. Where split-wired duplex receptacles are indicated, remove tabs connecting top and bottom receptacles.
  - L. Install wiring devices plumb and level with mounting yoke held rigidly in place.
  - M. Install wall switches with OFF position down.
  - N. Install wall dimmers to achieve full rating specified and indicated after derating for ganging as instructed by manufacturer.
  - O. Do not share neutral conductor on branch circuits utilizing wall dimmers.
  - P. Install vertically mounted receptacles with grounding pole on top and horizontally mounted receptacles with grounding pole on left.
  - Q. Install wall plates to fit completely flush to wall with no gaps and rough opening completely covered without strain on wall plate. Repair or reinstall improperly installed outlet boxes or improperly sized rough openings. Do not use oversized wall plates in lieu of meeting this requirement.
  - R. Install blank wall plates on junction boxes and on outlet boxes with no wiring devices installed or designated for future use.
  - S. Identify wiring devices in accordance with Section 26 0553.
- 3.4 FIELD QUALITY CONTROL
- A. See Division 01 - General Requirements.
  - B. Inspect each wiring device for damage and defects.
  - C. Operate each wall switch, wall dimmer, and fan speed controller with circuit energized to verify proper operation.
  - D. Test each receptacle to verify operation and proper polarity.
  - E. Test each GFCI protected receptacle for proper tripping operation according to manufacturer's instructions.
  - F. Inspect each surge protection receptacle to verify surge protection is active.
  - G. Correct wiring deficiencies and replace damaged or defective wiring devices.

3.5 ADJUSTING

- A. Adjust devices and wall plates to be flush and level.
- B. Adjust presets for wall dimmers according to manufacturer's instructions as directed by Architect.

3.6 CLEANING

- A. Clean exposed surfaces to remove dirt, paint, or other foreign material and restore to match original factory finish.

END OF SECTION 262726



## SECTION 262813 FUSES

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Fuses.
- B. Spare fuse cabinet.

#### 1.2 RELATED REQUIREMENTS

- A. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- B. Section 26 2818 - Enclosed Switches: Fusible switches.
- C. Section 26 2913 - Enclosed Controllers: Fusible switches.
- D. Section 26 4500 - Photovoltaic System: Additional requirements for photovoltaic fuses.

#### 1.3 REFERENCE STANDARDS

- A. NEMA FU 1 - Low Voltage Cartridge Fuses; 2012.
- B. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. UL 248-1 - Low-Voltage Fuses - Part 1: General Requirements; Current Edition, Including All Revisions.
- D. UL 248-4 - Low-Voltage Fuses - Part 4: Class CC Fuses; Current Edition, Including All Revisions.
- E. UL 248-8 - Low-Voltage Fuses - Part 8: Class J Fuses; Current Edition, Including All Revisions.
- F. UL 248-10 - Low-Voltage Fuses - Part 10: Class L Fuses; Current Edition, Including All Revisions.
- G. UL 248-12 - Low-Voltage Fuses - Part 12: Class R Fuses; Current Edition, Including All Revisions.
- H. UL 248-15 - Low-Voltage Fuses - Part 15: Class T Fuses; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Division 01: Requirements for coordination.

- B. Coordination:
  - 1. Coordinate fuse clips furnished in equipment provided under other sections for compatibility with indicated fuses.
    - a. Fusible Enclosed Switches: See Section 26 2818.
    - b. Fusible Switches for Enclosed Motor Controllers: See Section 26 2913.
  - 2. Coordinate fuse requirements according to manufacturer's recommendations and nameplate data for actual equipment to be installed.
  - 3. Notify Engineer of any conflicts with or deviations from the contract documents. Obtain written direction before proceeding with work.

## 1.5 SUBMITTALS

- A. See Division 01 - General Requirements.
- B. Product Data: Provide manufacturer's standard data sheets including voltage and current ratings, interrupting ratings, time-current curves, and current limitation curves.
  - 1. Spare Fuse Cabinet: Include dimensions.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Division 01 - General Requirements.
  - 2. Extra Fuses: One set(s) of three for each type and size installed.
  - 3. Fuse Pullers: One set(s) compatible with each type and size installed.
  - 4. Spare Fuse Cabinet Keys: Two.

## 1.6 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- C. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Bussman: [www.cooperindustries.com](http://www.cooperindustries.com).
- B. Littelfuse, Inc: [www.littelfuse.com](http://www.littelfuse.com).
- C. Ferraz Shawmut: [ferrazfuses.com](http://ferrazfuses.com).
- D. Substitutions: See Division 01 - General Requirements.

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## 2.2 APPLICATIONS

- A. Service Entrance:
  - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
  - 2. Fusible Switches Larger than 600 Amperes: Class L, time-delay.
- B. Feeders:
  - 1. Fusible Switches up to 600 Amperes: Class RK1, time-delay.
  - 2. Fusible Switches Larger than 600 Amperes: Class L, time-delay.
- C. General Purpose Branch Circuits: Class RK1, time-delay.
- D. Individual Motor Branch Circuits: Class RK1, time-delay.
- E. In-Line Protection for Pole-Mounted Luminaires: Class CC, time-delay.
- F. Primary Protection for Control Transformers: Class CC, time-delay.

## 2.3 FUSES

- A. Provide products listed, classified, and labeled as suitable for the purpose intended.
- B. Unless specifically indicated to be excluded, provide fuses for all fusible equipment as required for a complete operating system.
- C. Provide fuses of the same type, rating, and manufacturer within the same switch.
- D. Comply with UL 248-1.
- E. Unless otherwise indicated, provide cartridge type fuses complying with NEMA FU 1, Class and ratings as indicated.
- F. Voltage Rating: Suitable for circuit voltage.
- G. Class R Fuses: Comply with UL 248-12.
- H. Class J Fuses: Comply with UL 248-8.
- I. Class L Fuses: Comply with UL 248-10.
- J. Class T Fuses: Comply with UL 248-15.
- K. Selectivity: Where the requirement for selectivity is indicated, furnish products as required to achieve selective coordination.
- L. Provide the following accessories where indicated or where required to complete installation:
  - 1. Fuseholders: Compatible with indicated fuses.
  - 2. Fuse Reducers: For adapting indicated fuses to permit installation in switch designed for fuses with larger ampere ratings.

## 2.4 SPARE FUSE CABINET

- A. Description: Wall-mounted sheet metal cabinet with shelves and hinged door with cylinder lock, suitably sized to store spare fuses and fuse pullers specified.
- B. Finish: Manufacturer's standard, factory applied grey finish unless otherwise indicated.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that fuse ratings are consistent with circuit voltage and manufacturer's recommendations and nameplate data for equipment.
- B. Verify that mounting surfaces are ready to receive spare fuse cabinet.
- C. Verify that conditions are satisfactory for installation prior to starting work.

### 3.2 INSTALLATION

- A. Do not install fuses until circuits are ready to be energized.
- B. Install fuses with label oriented such that manufacturer, type, and size are easily read.
- C. Install spare fuse cabinet where indicated.
- D. Identify spare fuse cabinet in accordance with Section 26 0553.

END OF SECTION 262813

SECTION 262819 - ENCLOSED SWITCHES

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes fusible and nonfusible switches.
- B. Related Sections:
  - 1. Section 01 9113 – Building Commissioning Requirements.
  - 2. Section 26 2813 - Fuses.
  - 3. Section 26 0553 – Identification for electrical systems.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA FU 1 - Low Voltage Cartridge Fuses.
  - 2. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Product Data: Submit switch ratings and enclosure dimensions.

1.4 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Project Record Documents: Record actual locations of enclosed switches and ratings of installed fuses.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

## PART 2 PRODUCTS

### 2.1 FUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Siemens.
  - 4. Eaton/Cutler Hammer.
  - 5. Substitutions: See Division 01 – General Requirements.
- B. Product Description: NEMA KS 1, Type HD, enclosed load interrupter knife switch. Handle lockable in OFF position.
- C. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses.
- D. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.
- E. Furnish switches with entirely copper current carrying parts.

### 2.2 NONFUSIBLE SWITCH ASSEMBLIES

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Siemens.
  - 4. Eaton/Cutler Hammer.
  - 5. Substitutions: See Division 01 - General Requirements.
- B. Product Description: NEMA KS 1, Type HD enclosed load interrupter knife switch. Handle lockable in OFF position.
- C. Enclosure: NEMA KS 1, to meet conditions. Fabricate enclosure from steel finished with manufacturer's standard gray enamel.
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.
- D. Furnish switches with entirely copper current carrying parts.

### 2.3 SWITCH RATINGS

- A. Switch Rating: Horsepower rated for AC or DC as indicated on Drawings.
- B. Short Circuit Current Rating: UL listed for 200,000 rms symmetrical amperes when used with or protected by Class R or Class J fuses (30-600 ampere switches employing appropriate fuse rejection schemes).

PART 3 EXECUTION

3.1 INSTALLATION

- A. Install enclosed switches plumb. Provide supports in accordance with Section 26 0529.
- B. Height: 5 feet to operating handle.
- C. Install fuses for fusible disconnect switches. Refer to Section 26 2813 for product requirements.
- D. Install engraved plastic nameplates in accordance with Section 26 0553.
- E. Apply adhesive tag on inside door of each fused switch indicating NEMA fuse class and size installed.

3.2 FIELD QUALITY CONTROL

- A. See Division 01 – General Requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.5.

END OF SECTION 262819

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SECTION 262913 - ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes manual and magnetic motor controllers in individual enclosures.
- B. Related Sections:
- C. Related Sections:
  - 1. Section 01 9113 – Building Commissioning Requirements.
  - 2. Section 26 2813 - Fuses.
  - 3. Section 26 0553 – Identification for electrical systems.
  - 4. Section 26 2813 - Fuses.

1.2 REFERENCES

- A. National Electrical Manufacturers Association:
  - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches.
  - 2. NEMA FU 1 - Low Voltage Cartridge Fuses.
  - 3. NEMA ICS 2 - Industrial Control and Systems: Controllers, Contactors, and Overload Relays, Rated Not More Than 2000 Volts AC or 750 Volts DC.
  - 4. NEMA ICS 5 - Industrial Control and Systems: Control Circuit and Pilot Devices.
  - 5. NEMA ICS 6 - Industrial Control and Systems: Enclosures.
  - 6. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
- B. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

1.3 SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Product Data: Submit catalog sheets showing voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- C. Test Reports: Indicate field test and inspection procedures and test results.

1.4 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Project Record Documents: Record actual locations and ratings of enclosed controllers.
- C. Operation and Maintenance Data: Submit Replacement parts list for controllers.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing products specified in this section with minimum three years documented experience.

PART 2 PRODUCTS

2.1 MANUAL MOTOR CONTROLLER

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Eaton/Cutler Hammer.
  - 4. Cerus Industrial.
  - 5. Substitutions: See Division 01 - General Requirements.
- B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller with overload element, red pilot light, 1 NO and 1 NC auxiliary contact, and toggle operator.
- C. Enclosure: NEMA ICS 6, to meet conditions of installation.

2.2 FRACTIONAL-HORSEPOWER MANUAL CONTROLLER

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Eaton/Cutler Hammer.
  - 4. Cerus Industrial.
  - 5. Substitutions: See Division 01 - General Requirements.
- B. Product Description: NEMA ICS 2, AC general-purpose, Class A, manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, red pilot light, and toggle operator.
- C. Enclosure: NEMA ICS 6, to meet conditions of installation.

2.3 FULL-VOLTAGE NON-REVERSING CONTROLLERS

- A. Manufacturers:
  - 1. General Electric.
  - 2. Square D.
  - 3. Eaton/Cutler Hammer.
  - 4. Cerus Industrial.
  - 5. Substitutions: See Division 01 - General Requirements.
  
- B. Product Description: NEMA ICS 2, AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
  
- C. Control Voltage: 120 volts, 60 Hertz.
  
- D. Overload Relay: NEMA ICS 2; bimetal (electronic preferred).
  
- E. Product Features:
  - 1. Auxiliary Contacts General: NEMA ICS 2, 2 each, field convertible contacts in addition to seal-in contact.
  - 2. Cover Mounted Pilot Devices: NEMA ICS 5, heavy duty type.
  - 3. Pilot Device Contacts: NEMA ICS 5.
  - 4. Pushbuttons: Shrouded type.
  - 5. Indicating Lights: LED type.
  - 6. Selector Switches: Rotary type (HOA).
  - 7. Relays: NEMA ICS 2.
  - 8. Control Power Transformers: 120 volt secondary, in each motor starter. Furnish fused primary and secondary, and bond unfused leg of secondary to enclosure.
  
- F. Combination Controllers: Combine motor controllers with disconnect in common enclosure, using fusible switch conforming to NEMA KS 1, enclosed knife switch with externally operable handle. Fuse clips: Designed to accommodate NEMA FU 1, Class R fuses. Obtain IEC Class 2 coordinated component protection.
  
- G. Enclosure: NEMA ICS 6, to meet conditions. Fabricate enclosure from [steel finished with manufacturer's standard gray enamel].
  - 1. Interior Dry Locations: Type 1.
  - 2. Exterior Locations: Type 3R.

### PART 3 EXECUTION

#### 3.1 INSTALLATION

- A. Install enclosed controllers plumb. Provide supports in accordance with Section 26 0529.
- B. Height: 5 feet to operating handle.
- C. Install fuses for fusible switches. Refer to Section 26 2813 for product requirements.
- D. Select and install overload heater elements in motor controllers to match installed motor characteristics.
- E. Install engraved plastic nameplates. Refer to Section 26 0553 for product requirements and location.
- F. Neatly type label and place inside each motor controller door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating. Place label in clear plastic holder.

#### 3.2 FIELD QUALITY CONTROL

- A. See Division 01 – General Requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.16.1.

END OF SECTION 262913

SECTION 264113 LIGHTNING PROTECTION FOR STRUCTURES

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Strike (air) terminals and interconnecting conductors.
- B. Grounding and bonding for lightning protection.
- C. Description: Conductor system protecting entire building and having UL Master Label.

1.2 RELATED REQUIREMENTS

- A. Section 26 0526 - Grounding and Bonding for Electrical Systems: Electrical system grounds.
- B. Surge Protection for Wiring Systems: Specified in individual system requirements.

1.3 REFERENCE STANDARDS

- A. NFPA 780 - Standard for the Installation of Lightning Protection Systems;
- B. UL 96 - Lightning Protection Components; Current Edition, Including All Revisions.
- C. UL 96A - Installation Requirements for Lightning Protection Systems.
- D. Perform Work in accordance with UL 96A and furnish Master Label.

1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination with Concrete Work: Coordinate the embedding of lightning protection components in concrete.
- B. Coordination with Roofing Work: Ensure adequate attachment of strike terminals and conductors without damage to roofing.
- C. Coordinate with all trades to ensure a correct, neat and unobtrusive installation.
- D. Pre-installation Meeting: Convene a meeting at least two weeks prior to commencement of any work affected by lightning protection system requirements to discuss prerequisites and coordination required by other installers; require attendance by representatives of installers whose work will be affected.

1.5 SUBMITTALS

- A. See Division 1 – General Requirements.
- B. Shop Drawings: Indicate location and layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode, and conductor sizes, and connection and termination details.
  - 1. Where conductors or grounds are to be embedded or concealed in other construction, submit shop drawings at least 30 days prior to start of construction.
  - 2. If concrete-encased grounds are to be used and are not shown in the contract documents, provide sufficient data to determine concrete encasement dimensions and location.
  - 3. Include data on actual ground resistance determined by field measurement in accordance with NFPA 780.
  - 4. Include engineering analysis of equalization of potential to metal bodies within the structure.
  - 5. Include access panels, test holes, and disconnecting means for maintenance.
- C. Product Data: Provide dimensions and materials of each component, indication of testing agency listing, and installation instructions.
- D. Manufacturer's Certificate: Certify that products meet or exceed specified requirements.
- E. Installation Certification: Submit copy of certification agency's UL Master Label approval.
- F. Operation and Maintenance Data: Provide recommended inspection and testing plan, including recommended intervals, to achieve periodic maintenance as recommended in NFPA 780; provide customized plan reflecting actual installation configuration with specific installed components identified.
- G. Project Record Documents: Record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors in project record documents.

1.6 QUALITY ASSURANCE

- A. Maintain one copy of each referenced system design standard on site.
- B. Manufacturer Qualifications: Company specializing in lightning protection equipment with minimum three years documented experience.
- C. Designer Qualifications: Person or entity, employed by installer, who specializes in lightning protection system design with minimum three years documented experience.
- D. Installer Qualifications: Capable of providing the specified certification of the installed system.

- E. Installer Qualifications: Company specializing in lightning protection system design with minimum three years documented experience.
- F. Field Quality Control Testing Agency Qualifications: Firm capable of and experienced in grounding and bonding testing with documented experience and minimum of three project references.
- G. Products: Listed, classified, and labeled as suitable for the purpose intended.
- H. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.
- I. Design lightning protection system under direct supervision of NFPA 780 Certified Designer experienced in design of this Work and licensed in State where work is performed.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Lightning Protection Components:
  - 1. Advanced Lightning Technology: ALTwww.altfab.com.
  - 2. Harger Lightning and Grounding: www.harger.com.
  - 3. thermOweldae, subsidiary of Continental Industries; division of Burndy LLC: www.thermoweld.com.
  - 4. Substitutions: See Division 1- General Requirements.

### 2.2 LIGHTNING PROTECTION SYSTEM

- A. Lightning Protection System: Provide complete system complying with NFPA 780, including air terminals, bonding, interconnecting conductors and grounding electrodes.
  - 1. Provide system that protects:
    - a. The entire structure.
    - b. Open air areas within building footprint.
  - 2. Coordinate with other grounding and bonding systems specified.
  - 3. Treat isolated non-grounded protruding metal items as specified by NFPA 780 for heavy-duty stacks.
  - 4. Determine ground resistance by field measurement.
  - 5. Provide copper, bronze, or stainless steel, components, as specified in following sections.
  - 6. Provide disconnecting means and access panels or similar devices to allow complete periodic inspection and testing as described by NFPA 780 Annex D.
  - 7. Provide materials that are galvanically compatible with the structure and system components.
  - 8. Provide system certified by Underwriters Laboratories or the Lightning Protection Institute.
  - 9. Conceal all downleads within structure.

- B. Strike Terminals: Provide as required by system design.
- C. Strike Terminals: Provide strike (air) terminals on the following:
  - 1. Roofs.
  - 2. Parapets.
  - 3. Roof mounted equipment.

## 2.3 COMPONENTS

- A. All Components: Complying with applicable requirements of UL 96.
- B. Strike (Air) Terminals: Copper, solid, with adhesive bases for single-ply roof installations.
- C. Grounding Rods: Solid copper.
- D. Ground Plate: Copper.
- E. Conductors: Copper cable.
- F. Connectors and Splicers: Bronze.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Verify that field measurements are as indicated on shop drawings.
- B. Coordinate work with installation of roofing and exterior and interior finishes.

### 3.2 INSTALLATION

- A. Install in accordance with referenced system standards and as required for specified certification.
- B. Connect conductors using mechanical connectors or exothermic welding process; protect adjacent construction elements and finishes from damage.
- C. Connect conductors using mechanical connectors.
- D. Connect conductors using exothermic welding process; protect adjacent construction elements and finishes from damage.
- E. Downloads from roof to grade shall be routed within building envelope. Exposed downloads are not acceptable.



3.3 FIELD QUALITY CONTROL

- A. See Division 1, for additional requirements.
- B. Perform visual inspection as specified in NFPA 780 as if this were a periodic follow-up inspection.
- C. Perform continuity testing as specified in NFPA 780 as if this were testing for periodic maintenance.
- D. Obtain the services of the specified certification agency to provide inspection and certification of the lightning protection system, including performance of any other testing required by that agency.
- E. Perform inspection and testing in accordance with UL 96A.

END OF SECTION 264113

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SECTION 264500 - PHOTOVOLTAIC SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. Each and every Contractor, Subcontractor and/or supplier providing goods or services referenced in or related to this section shall also be bound by the Documents identified in Division 1.

1.2 SUMMARY

- A. Section includes complete photovoltaic system including the following
  1. Solar electric modules
  2. Racking System
  3. Power Optimizers
  4. Grid Tied Inverters
  5. Web Based System Monitoring
  6. Surge Protection
  7. Utility Meter
  8. Labeling
  9. Balance of System components
- B. Related Sections:
  1. Section 019113 – General Commissioning Requirements and related specification sections apply.
  2. Section 07 8413 – Penetration Firestopping: Product requirements for firestopping for placement by this section
  3. Section 07 7200 – Roof Accessories.
  4. Section 26 0501 – Basic Materials and Methods
  5. Section 26 0526 - Grounding and Bonding for Electrical Systems.

1.3 REFERENCES

- A. North American Board of Certified Practitioners (NABCEP).
- B. Institute of Electrical and Electronics Engineers:
  1. IEEE 1547 - Standard for Interconnecting Distributed Resources with Electric Power Systems.
  2. ANSI/IEEE Standard C62.41, Guide for Surge Voltages in AC Power Circuits.
- C. National Fire Protection Association:
  1. NFPA 70 - National Electrical Code.
- D. Underwriters Laboratories Inc.:
  1. UL 1449 (2014; Reprint Jul 2017) UL Standard for Safety Surge Protective Devices
  2. UL 1703 – Flat-Plate Photovoltaic Modules and Panels

3. UL 1741 – Inverters, Converters, Controllers and Interconnection System Equipment for Use with Distributed Energy resources.
4. UL 2703 (2015) UL Standard for Safety Mounting Systems, Mounting Devices, Clamping/Retention Devices, And Ground Lugs For Use With Flat-Plate Photovoltaic Modules And Panels
5. UL 969 (2017) UL Standard for Safety Marking and Labeling Systems
6. FM Global Data sheet 1-15 – Roof-Mounted Solar Photovoltaic Panels

#### 1.4 SYSTEM DESCRIPTION

- A. The PV system described in this document is of the grid-connected type and does not include battery/backup storage or secondary electrical generation devices. PV system feeds AC power into the local services when solar energy is available and immediately disconnects from the grid upon loss of grid power to the service in accordance with IEEE 1547 and local utility regulations.

#### 1.5 BASIS OF DESIGN

- A. The system is based on string inverters connected to power optimizers mounted to the PV module frame. Each power optimizer shall serve one PV modules. The design of the system is based on specific manufacturer's equipment as indicated on the drawings. Acceptable substitutions of equipment will be considered, however deviations from the design will require the contractor to provide revised documentation for Permitting, Utility interface, and grant application. Documentation shall include engineering calculations for system capacities (min/max), wire sizing, and inverter/module compatibility. If substitutions from basis-of-design system require additional structural work to the roof or building the Contractor shall provide the additional structural work at no additional cost to the Owner.
- B. Array and branch circuit arrangement, as indicated on the drawings, is specific to the module and inverter manufacturer listed. Any deviation from the manufactures listed in the schedules on the drawings will require additional calculations and design by the contractor.
- C. Acceptable alternate equipment shall have efficiencies within +/-3% for Modules and +/- 3% for inverters.
- D. Structural Engineering: The roof and structure of the building is limited in its capacity to support the weight of the PV system. The designed system includes structurally connected PV arrays. The structurally connected PV array shall be connected to the standing seam metal roof and all penetrations shall be coordinated and compatible with the roofing systems. As part of the basis of design the contractor shall provide stamped and signed drawings by a structural engineer that cover racking components, attachments and PV system design criteria.

#### 1.6 EXTRA MATERIALS

- A. Provide 1 solar module for every 50 solar panels and 1 power optimizer or micro inverter for every 100 units.

1.7 SUBMITTALS

- A. See Section 01 – General Requirements.
- B. Shop Drawings:
  - 1. Provide shop drawings and data sheets of all components within the solar system.
  - 2. Indicate voltage (Maximum, Minimum, and Open Circuit), voltage AC, Ampacity string size, inverter characteristics, and physical sizes for major equipment.
  - 3. Indicate total kW for project matching design criteria.
  - 4. Provide weight of entire system including ballasting (where applicable). Provide plan indicating exact weight and location of ballasts for Structural Engineer Review. Provide plan indicating exact location of structural steel connections.
  - 5. Provide 3-line diagram of entire system.
  - 6. Provide Installers North American Board of Certified Energy Practitioners (NABCEP) certificate.
  - 7. Provide a copy of the Utility interconnection application.
  - 8. Provide PE stamped roof drawing showing final layout of racking system and structural details. Refer to Section 2 for additional requirements.
  - 9. Modifications to original drawings made during installation must be immediately recorded for inclusion into the as-built drawings. When items have changed relative to the approved design, the designer must provide certification indicating that the changes will not negatively affect the system's operation or the structure supporting the system.
- C. Product Data: Submit catalog data showing specified features, capacities and ratings of products provided.
  - 1. Combiner Boxes
  - 2. Disconnects
  - 3. Inverters
  - 4. Power Optimizers
  - 5. String Inverter CEC Efficiency
  - 6. Roof Mounting Structure for Modules (Racking)
  - 7. Photovoltaic Modules
  - 8. Photovoltaic Wire
  - 9. System Monitoring
- D. Materials
  - 1. Provide materials and equipment that are products of manufacturers regularly engaged in the production of such products which are of equal material, design and workmanship. Submit proof of compliance with requirements of UL, where material or equipment is specified to comply. The label of or listing in UL Electrical Construction Directory will be acceptable evidence. In lieu of the label or listing, a written certificate from an approved nationally recognized testing laboratory (NRTL) equipped to perform such services, stating that the items have been tested and conform to the requirements and testing methods of Underwriters Laboratories may be submitted.

1.8 CLOSEOUT SUBMITTALS

- A. See Section 01 – General Requirements.
- B. Project Record Documents: Record actual locations of modules, inverters, string locations and Junction boxes and record actual circuiting arrangements.
- C. Operation and Maintenance Data: Submit spare parts listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals, and warrantee information.

1.9 QUALIFICATIONS

- A. Manufacturer of equipment
  - 1. Company specializing in manufacturing products specified in this section and listed as eligible equipment by the State of California Energy Commission.
  - 2. Equipment shall be UL listed.
- B. Contractor: Installer and/or their field supervisor shall be a “Certified PV Installation Professional” under the North American Board of Certified Practitioners (NABCEP).
- C. Installer shall be an approved solar photovoltaic contractor by Connecticut Green Bank.

1.10 APPLICATIONS AND UTILITY INTERCONNECTIONS

- A. Contractor shall provide a completed Interconnection Application to the utility company as required for connection of the Photovoltaic System to the electric utility grid. Contractor shall include the costs and Utility Fees for submitting application, witness tests, and Utility Solar Meter as required by the utility.
- B. Coordinate and follow up with utility company for the connection of the system to the grid and provide a Utility Net Meter. Obtain agreements with the utility company on behalf of the owner.
- C. Contractor shall include all cost associated with completing applications, follow up with agencies and utilities, application and witness tests costs by the utility and securing agreements on behalf of the owner.
- D. Contractor shall provide witness test procedure to the utility company per their requirements and acquire witness test approvals from the utility company. Coordinate a time for the witness test with the utility company and perform the test per utility company requirements. Contractor is responsible to be present for the test, perform the test, make any adjustments as required, and provide any tools, meters, etc. as the utility company requires for completion of the test.

### 1.11 DELIVERY, STORAGE, AND HANDLING

- A. Store solar PV modules in their original packaging according to the manufacturer's guidance, and do not remove from packaging until day of installation.
- B. If a solar PV module is removed from its packaging, store it according to the manufacturer's guidance.
- C. Do not store solar PV modules on-site for more than 6 months.
- D. Secure all solar equipment and modules to prevent damage or theft.

### 1.12 WARRANTY

- A. All warranties listed herein shall be inclusive of labor and equipment and shall start at date of acceptance by commissioning agent and continue for a period of 2 years (unless noted otherwise in this section).

## PART 2 PRODUCTS

### 2.1 System Requirements

- A. Conform electrical installations to IEEE C2, NFPA 70, and requirements specified herein.
- B. All equipment must be listed and labeled in accordance with OSHA-listed nationally recognized testing laboratories (NRTL) and installed in accordance with the listing requirements and the manufacturer's instructions.
- C. Provide all accessories needed for a complete, secure, operational grid-tied PV system.
- D. Wiring and connections of inverters, PV source circuits, AC branch circuits, and all interconnections must be rated at a minimum for IP65 in accordance with NEMA IEC 60529.

### 2.2 SOLAR ELECTRIC MODULES

- A. Furnish the solar photovoltaic module manufacturer's warranty. The warranty must be a 25-year linear 80 percent (minimum) power warranty (at the end of the 25th year after purchase an actual minimum power output of 80 percent based on the nameplate rating must be achieved) and not less than 10-years for workmanship material and manufacturing defects from the date of manufacture. The warranty must state that the malfunctioning solar photovoltaic module must be exchanged by the manufacturer and promptly shipped to the owners facility. The replacement solar module must be identical to, or an improvement upon, the original design of the malfunctioning solar module.

- B. Manufacturers:
1. LG Electronics (Basis of Design).
  2. SunPower
  3. QCells
  4. Equivalent modules will be acceptable if they meet or exceed the performance of the basis of design module and of similar construction and physical dimension and weight.
  5. Substitutions: See Section 01 – General Requirements.
- C. Product Description: Modules shall be mono/poly-crystalline solar cells with the following characteristics.
1. 72 cell module (Basis of Design LG Neon 2 #LG400N2W-V5).
  2. Module Efficiency: 19.3%
  3. STC Watts: 400 watts
  4. Output Tolerance: -0% to +3%
  5. Maximum system voltage: 1000V
  6. MPP Voltage: 40.6 V
  7. MPP Current: 9.86 A
  8. Outside dimensions: 79.69" x 40.31 " x 1.57 "
  9. Weight: 47.84 lbs
  10. High transmission tempered glass
  11. Output Linear Warranty of Pmax:
    - a. 1st year: 98%
    - b. After 1st year: 0.55% annual degradation
    - c. 25 year: 84.8%
- D. Module connection shall be MC4 12AWG or equivalent for easy connection and disconnection of individual modules. Wiring, conduit, junction boxes, etc shall be neatly arranged.
- E. Frame shall be clear anodized aluminum.
- F. Modules shall not contain any foam plastic, such as extruded foam polystyrene, unless specifically FM Global approved as part of the assembly.
- G. Photovoltaic wire, wiring methods, and utilization of locking-type connectors must comply with the requirements of NFPA 70. Provide USE-2 or RHH or RHW-2 wire, and sunlight-resistant wire when exposed to sunlight.

### 2.3 STRING INVERTERS

- A. Furnish the inverter manufacturer's warranty. The warranty period must be 15 years (minimum) from the date of manufacture. Inverter device installation, transportation, and on-site storage must not exceed 12 months, thereby permitting 14 years of the 15 year warranty to be in service and energized. The warranty must state that the malfunctioning inverter must be exchanged by the manufacturer and promptly shipped to the facility, and arrive in no more than ten days. The replacement inverter must be identical to, or an improvement upon, the original design of the malfunctioning inverter.



- B. Manufacturers:
  - 1. Solaredge 3-phase String Inverters (Basis of Design)
  - 2. SMA 3-phase string Inverters
  - 3. Solectria 3-phase string inverters
  - 4. Substitutions: See Section 01 – General Requirements
  
- C. Product Description: String inverters shall be mounted to a custom fabricated support at the location shown on plans, and tied to power optimizers mounted directly behind modules by utilizing product specific wiring harness and cables. The Inverters shall have the following characteristics:
  - 1. UL 1741 listed.
  - 2. Output: As indicated on drawings.
  - 3. 3 phase, 208Y/120, 60HZ output.
  - 4. Designed for installation where there is full sun, driving rain and drifting snow.
  - 5. Power Factor = 1 (adjustable from -0.8 to +0.8)
  - 6. Outdoor NEMA 3R enclosure.
  - 7. Grounding: Grounding shall be provided as per manufacturer installation instructions and per NEC Art. 690.
  - 8. Rapid Shutdown: Provide Solaredge 3-phase string inverter rapid shutdown kit for each inverter.
  
- D. Capacity: String inverters shall be sized to match the module and overall system production taking into account record low temperature and average high temperatures.
  
- E. Communication Capabilities: Connection to building's network via CAT6 wiring.
  
- F. Product Warrantee: 12 years.

## 2.4 POWER OPTIMIZERS

- A. Manufacturers:
  - 1. Solaredge Power Optimizer (Basis of Design)
  - 2. Tigo Power Optimizer
  - 3. Innovative Solar Inc.
  - 4. Substitutions: See Section 01 – General Requirements
  
- B. Product Description: Power optimizers shall be mounted directly behind modules by utilizing product specific wiring harness and cables. Power Optimizer output circuits shall be circuited to string inverters as indicated on drawings. The power optimizers shall have the following characteristics:
  - 1. UL 1741 listed.
  - 2. IEC62109-1 (Class II safety)
  - 3. Output: 15A<sub>dc</sub>, 85V<sub>dc</sub>
  - 4. Designed for installation where there is full sun, driving rain and drifting snow.
  - 5. Power Factor = 1 (adjustable from -0.8 to +0.8) set at the string inverter.
  - 6. Outdoor IP68/NEMA 6P enclosure.
  - 7. Grounding: Grounding shall be provided as per manufacturer installation instructions and per NEC Art. 690.

- C. Capacity: Power optimizer/Module string quantities shall be sized following manufacturer recommendations and taking into account record low temperature and average high temperatures.
- D. Product Warrantee: 25 years.

## 2.5 STRUCTURALLY CONNECTED RACKING SYSTEM

- A. Provide racking for array as indicated on the drawings, including the module azimuth and tilt for each inverter's separate array. Provide racking compliant with UL 2703.
- B. Racking and PV array, including modules, hardware, and attachments, must withstand snow loads and wind loads as required by ASCE 7 and ICC IBC.
- C. Racking must be suitable for the local Seismic Design Category as defined by ASCE 7 and ICC IBC.
- D. Racking and roof attachment shall be designed in accordance with FM Global Data Sheet 1-15: Roof-Mounted Solar Photovoltaic Panels
- E. Submit seismic and wind and snow load design calculations for the array mounting system and its attachment to the structure showing compliance with seismic and wind and snow requirements while supporting the PV modules.
- F. Provide the mechanical hardware for mounting the PV arrays and all other hardware required for assembling the PV modules, and the attachments to the building structure.
- G. Roof Attachment: Roof attachment to the standing seam metal roof shall utilize set screw clamping mechanism as manufactured by "S-5" or approved equal. Coordinate clamp model with the standing seam metal roof design.
- H. Manufacturers:
  - 1. Ironridge (Basis of Design)
  - 2. Preformed Line Products
  - 3. Schletter
- I. Submittal Requirements: Contractor shall provide a roof plan stamped by a Connecticut Professional Engineer showing structural calculations of the racking system to be provided. Package shall include at a minimum:
  - 1. Roof layout showing final module configurations
  - 2. Roof layout showing final racking configurations
  - 3. Roof layout showing final location of structural connections to building steel
  - 4. Structural calculation sheet demonstrating system selection based on wind and snow loads.
  - 5. Detail of structural connection
  - 6. Section of the racking configurations

- J. Product Description: Structurally connected racking system
    - 1. Custom fabricated roof connected racking system to compliment curved architectural building elements
    - 2. Material shall be aluminum
    - 3. Hardware shall be stainless steel
    - 4. Warranty shall be 20 years minimum
  - K. Racking system shall be able to easily accommodate the specified modules without making modifications to the racking system on site and utilizing the manufacturer's standard fasteners.
  - L. Stainless steel fasteners shall be used on the racking system.
  - M. Systems shall meet or exceed the minimum structural requirements including wind and snow loads.
  - N. Provide all required manufacturer approved hardware for a complete and functional installation, including but not limited to mounting brackets for devices such as optimizers, inter-row high voltage wiring management, wind deflectors, conduit supports, approved electrical boxes rated for exterior environment, etc.
  - O. All PV modules and key components shall be accessible and serviceable from below the mounting system.
- 2.6 COMBINER BOXES
- A. All combiner boxes must be listed to UL 1741, and inspected before commissioning, testing, and operation of the system.
  - B. Provide combiner boxes support structure mount, NEMA 4/4X outdoor steel enclosures in accordance with NEMA 250.
  - C. Supply combiner boxes designed for use with the inverter provided, and coordinated to the specific PV source circuit design.
  - D. Provide combiner boxes of compact design with simplified input and output wiring.
  - E. Provide overcurrent protection and output disconnecting means that comply with the requirements of NFPA 70.
- 2.7 CABLE TIES
- A. Manufacturers:
    - 1. Partex Marking Systems (Basis of Design)
    - 2. Panduit Corporation
    - 3. HellermannTyton
    - 4. Substitutions: Section 01 61 00 – Basic Product Requirements

- B. Product Description: Cable ties for securing DC and exposed ground wiring to PV racking system. Wiring shall be neat and organized by utilizing cable ties and securing the wiring to the frame of the racking system. Wiring shall be secured to avoid loops and dropping in wiring and to prevent grab points. Wiring shall be secured so that it cannot come into contact with the roof or related components.
  - 1. Cable ties shall be polyester coated 316 stainless steel, fire proof, UV Resistant and tightly secured at all points.

2.8 WEB BASED MONITORING SYSTEM

- A. Manufacturers:
  - 1. Solaredge Control and Communication gateway (Part#SE1000-CCG-G)
  - 2. Substitutions: See Section 01 – General Requirements.
- B. Product Description: Provide a web based monitoring system that records and displays historical and real time PV production in graphical form for each individual module/inverter pair.
- C. System shall report revenue grade data with instantaneous and historical data capabilities. Historical data shall include daily, weekly and monthly data for a period of 5 years.
- D. Data access shall be available via the internet 24 hours a day, 7 days a week.
- E. System shall include all necessary communication wiring, connections and meters for complete operational system.
- F. Contractor shall connect Solar Edge monitoring system to the Buildings Switch/router for internet access, install, test and run software with the aid of the Owner’s IT professional. Contractor shall cooperate and coordinate with the Owner’s IT professional.
- G. Provide online software setup of entire system, including graphical representation of modules/inverters in plan view showing them in their final location on the Roof plan. This is a critical item to provide a means for the Owner to troubleshoot individual inverters and the associated PV arrays. Provide Owner with full access login credentials.

2.9 SURGE PROTECTION

- A. Manufactures:
  - 1. Siemens Industry.
  - 2. Substitutions: See Section 01 – General Requirements.
- B. Provide AC lightning Arrestor for each inverter (LA603)
  - 1. Provide a UL 1449 4th Edition listed ‘Type 1’ SPD
  - 2. Design: Thermally Protected Metal Oxide Varistors (TPMOVs)
  - 3. Maximum Current: 50,000A per phase
  - 4. I-nominal Rating: 20 kA
  - 5. Modes of Protection: Line to Ground and Ground to Neutral
  - 6. UL 1449 4th Ed. Voltage Protection Ratings:

<u>System Voltage</u>	<u>L-G</u>	<u>G-N</u>	<u>L-L</u>
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120/208 Wye	600V	600V	1000V
277/480V	1200V	1000V	2000V

7. Type 1 SPDs can be direct bussed. When specified connected to a breaker, the SPD breaker must be selected to comply with NEC 240.4(B). If SPD is pre-wired with #10 AWG copper conductors, per NEC 240.4(B)(7), the SPD can be connected to a breaker having a maximum amperage of 30A.

## 2.10 UTILITY METER

- A. Manufacturers:
1. Net meter as required by the Utility Company.
- B. Product Description: Provide a three phase revenue meter as required by the Utility Company.

## 2.11 LABELING

- A. Product Description: Labels shall be in accordance with the latest applicable edition of NFPA70 (National Electrical Code), NFPA1, ANSI Z535.4, and as required by the local Authority Having Jurisdiction.
- B. Provide Lamacoid (3-ply laminated engraving plate) 11"x17" one-line diagram that is permanently mounted in the main electrical room. One-line shall show all interconnections of the PV system to the electrical distribution system as well as all disconnects and physical locations similar to the electrical riser diagram provided in the contract documents. Lamacoid placard shall be white with black lettering; shutoff switches shall be indicated with red characters.
- C. Provide Lamacoid (3-ply laminated engraving plate) 11"x17" Site Plan that is permanently mounted in the main electrical room or adjacent to the solar main disconnect. Site Plan shall show all interconnections of the PV system to the electrical distribution system as well as all Disconnects, Inverters and roof mounted PV arrays. Lamacoid placard shall be white with black lettering; shutoff switches shall be indicated with red characters.
- D. Labels located outdoors shall be weather and sunlight resistant. Labels shall be typewritten and permanently affixed. Provide reflective labels as per NEC requirements.
- E. Provide additional labeling as indicated on contract documents.
- F. Provide DC conductor labeling for all solar components. Each conductor shall be permanently labeled on both ends of the conductor indicating conductor number.

## 2.12 GROUNDING AND BONDING

- A. Provide properly sized equipment grounding conductors.

- B. Provide bonding fittings on concentric/eccentric knockouts with metal conduits for circuits over 250 volts in accordance with NFPA 70.
- C. Provide bonding fittings for ferrous metal conduits enclosing grounding electrode conductors in accordance with NFPA 70.
- D. Provide grounding for aluminum PV solar module frames and racking of either stainless steel or tin-coated copper. Lugs shall be UL listed for exterior use.

## PART 3 EXECUTION

### 3.1 UTILITY INTERCONNECTION

- A. Utility Company Interconnection Application: Provide documentation required by the Utility Company for interconnection of the PV system to the Utility grid and installation of the Net-Meter.
  - 1. Secure Interconnection Agreement from the Utility Company and schedule a witness test and interconnection time with the Utility Company when the system has been installed, tested and commissioned by the contractor. Include Utility Witness Test and other associated Fees.
  - 2. Submit Interconnection agreement and associated fees to the Utility Company prior to start of work and establish a schedule with Utility Company so as not to delay the project waiting for final connection. Schedule shall be mutually agreeable to contractor, owner and the Utility Company and be within the time frame of the overall project completion date.
  - 3. Provide witness test procedure to the Utility Company for approval prior to witness test.

### 3.2 PERMITS

- A. Permitting: Identify and apply for all permits required for installation of the Photovoltaic System. Include all associated Permit fees in bid.
  - 1. Coordinate and schedule the final inspection with the local authority having jurisdiction.
  - 2. If contractor has selected substitutions to product specified, contractor must provide revised documents that indicate the required changes to the project based on the substitutions. The documents shall be stamped and signed by a Professional Engineer and submittal to the inspectors for review with the permit application. Substitutions must be approved through the shop drawing submission process.

### 3.3 INSTALLATION

- A. Under no circumstances shall a ballast block, framing member, junction box, conduit, architectural element or any other item shade the modules. Plan out locations of conduits, conduit roof penetrations, junction boxes, structural steel racking connections, etc., prior to installation. Notify Engineer of any conflicts that cannot be resolved prior to installation.

- B. Provide schedule for all work for approval by Construction Manager and Owner. Schedule shall be in Gant Chart format indicating major milestones, critical path items, and total length of time for each milestone and project as a whole.
- C. Installation shall meet the requirements of local, State, Federal, and OSHA requirements. Installation shall be in compliance with the State Building Code and National Electrical Code.
- D. The system shall maintain roof and structural integrity. Coordinate with the roofing contractor to ensure that the building roof warranty and the integrity of the roof itself shall not be compromised by the installation.
- E. Site shall be kept secure and free of excessive debris and in safe condition during the construction period. Site shall be left “broom clean” after work is complete and at the end of each work day.
- F. Properly secure the site during construction to ensure no tampering, vandalism, theft or accidents occur while the site is in an unfinished state. Maintain personnel on site to monitor activities and prevent unauthorized personnel from entering the construction area where partially installed systems may be present. Secure and make safe all electrical wiring and connections.
- G. The use of ferrous metals, wood, or plastic components are not acceptable. Provide stainless steel fasteners and aluminum support structures. Special attention shall be paid to minimize damaging existing structure (if applicable) and roof with sharp edges, exposed fasteners or structure during construction.
- H. All bolted hardware, including stainless steel and aluminum metals, shall use anti-seize lubricant on threads and shall be torqued in accordance with manufactures specifications.
- I. Wiring
  - 1. Wiring shall be in accordance with Section 690 of the National Electrical Code. Wiring shall have a temperature rating of 90 degree C or higher.
  - 2. Exposed electrical conduits shall be rigid galvanized. Exposed cables shall be UV resistant.
  - 3. Outdoor enclosures shall be NEMA 4 or as indicated on plans.
  - 4. Conduits on roof shall be mounted on high-density polyethylene (HDPE) supports such as Pipe Pier or equivalent. Supports shall be compliant with the roof membrane.
  - 5. All roof mounted conduits must be mounted greater than 3.5” above the roof surface.
  - 6. Inter-row spacing:
    - a. Provide rigid galvanized conduits, with insulating bushings, when DC wiring passes between rows and when exposed to physical damage. Conduits shall be secured to racking systems on both sides or secured to junction boxes when applicable.

### 3.4 ROOF MOUNTED STRUCTURES

- A. Ensure roof access points, paths, and clearances are as indicated.
- B. The solar photovoltaic system details must be accepted by warranty roofing system manufacturer prior to installation. Upon completion of a rooftop system installation, obtain written certification that the rooftop warranty is still valid.
  - 1. For installation on a new roof, coordinate with roof manufacturer of new roof and obtain certificate.
  - 2. For installation on existing roof, coordinate with activity to provide certificate of continued validity of warranty from manufacturer.
- C. Flash and counter-flash all roof penetrations in accordance with ICC IBC.
- D. Provide a minimum 4.5 inches air gap between the solar PV module frame and the roof surface.
- E. Comply with requirements in NRCA 3767 for working with different roof types.

### 3.5 LABELING AND IDENTIFICATION

- A. Provide plan layout of array with each inverter serial number labelled on the plan in its final location. Submit plan with as-builts for Owner's future use.
- B. Provide labeling in accordance with the latest applicable version of National Electrical Code, and as required by fire marshal and any other local authority having jurisdiction.

### 3.6 DELIVERY, STORAGE, AND HANDLING

- A. PV modules and system components shall be delivered to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations.
- B. Maintain the integrity of the installation site during delivery, handling and installation, including layout mats, insulation/plywood layers, etc. Any damage to the roof surface or landscaping shall be identified and repaired.
- C. Cranes shall be in compliance with local codes and requirements.
- D. Each module, inverter, and combiner box shall be physically inspected for defects and damage and replaced as necessary.
- E. Do not place pallets of equipment or modules directly on roof. Extreme caution and planning must be used when storing equipment and ballast so as NOT to overload any specific area of the roof during construction. Use of wheeled transport equipment on the roof must be used in accordance with the roofing manufacture.



3.7 FIELD QUALITY CONTROL

- A. Provide all terminations and connections of electrical wiring fully tightened, secured and strain relieved as appropriate. Protect all exposed wiring whips, etc. in a neat and organized fashion.

3.8 COMMISSIONING AND TESTING

- A. Provide testing in accordance with the Utility Company's Interconnection Agreement.
- B. Provide testing and demonstration of system per the inspection process as described in Utility Company's Interconnection Agreement.
- C. Provide a system safety inspection and start up that includes the following documented tests.
  - 1. Inverter start-up tests as specified by the inverter manufacturer as outlined in the inverter operation manual.
  - 2. Provide readings of actual versus predicted power.
  - 3. Loss of grid power where inverter automatically and immediately turns off and does not connect to the utility until 5 minutes after utility power is restored.
  - 4. Random Module shading
  - 5. Data Monitoring check out. Including internet conductivity and display.
  - 6. Measure Voc of every source circuit.
  - 7. Measure AC power and compare predicted power.
  - 8. Label all wiring terminations and enclosures.
  - 9. Inspect PV array quick connectors and fully mate wire connectors.
  - 10. Clean debris off the modules and visual inspect modules to identify and replace broken or damaged modules.
- D. Correct any deficiencies uncovered by the testing prior to commissioning system.
- E. Clear site of all tools and materials required for construction and installation.
- F. Measure system outputs as follows and provide written documentation to Engineer for baseline system performance:
  - 1. Establish initial system output to prove that the system is performing as it is designed and to establish a baseline to use for warranty.
  - 2. Include voltage, amps, power output tests.
  - 3. Test radiation levels at time of tests and note for reference.
  - 4. System measurements shall be performed and logged on a clear sunny day.

3.9 OPERATING AND MAINTENANCE MANUALS

- A. See Section 01 – General Requirements
- B. Prepare operating and maintenance manuals in accordance with the requirements of Division 1 and as follows. The Contractor shall prepare six (6) copies of a complete maintenance and operating instructions manual, bound in booklet form. Organize operating and maintenance data into suitable sets of manageable size. Bind properly indexed data in individual heavy-duty, 3-ring, vinyl-covered binders, with pocket folders

for folded sheet information. Mark appropriate identification on front and spine of each binder. Provide a digital copy of all documents in a storage drive to the owner (USB flash drive).

- C. Manual shall include the following:
1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
  2. As built plans showing the final placement of all panels, disconnects, combiner boxes, connections (tags) and conduit placement.
  3. As built electrical plans, including three line diagrams, showing the final placement of electrical equipment.
  4. Manufacturer's printed operating procedures to include start-up, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
  5. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
  6. Baseline performance readings from testing activities.
  7. Trouble shooting guidelines.
  8. Emergency instructions.
  9. Contact information for technical assistance and parts ordering.
  10. Copies of warranties.
  11. Provide plan layout of array with each inverter serial number labelled on the plan in its final location. Submit plan with as-builts for Owner's future use.
  12. Approved Shop Drawings and Product Data.

### 3.10 TRAINING

- A. Provide training in accordance with Section 01 – General Requirements.

END OF SECTION 264500

SECTION 265100 – INTERIOR ARCHITECTURAL LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All luminaires and lighting equipment shall comply with related sections of this project's specification, including Divisions 00 Procurement and Contracting Requirements; 01 General Conditions; 26 Electrical Requirements, 26 09 23 Lighting Controls, and 26 56 00 Exterior Lighting.

1.2 DESCRIPTION

- A. This section specifies the furnishings, installation and connections of the interior lighting.
- B. Work Included: Provision of materials, installation and testing of:
  - 1. Luminaires
  - 2. Ballasts, Drivers and Power Supplies
  - 3. Lamps
- C. Luminaires shall be provided complete with necessary accessories for proper installation.
- D. Specifications and drawings convey the features and functions of luminaires only and do not show every item or detail necessary for the work.
- E. Work includes final aiming and focusing of luminaires under direction of the Architect, Lighting Designer, or Engineer.

1.3 QUALITY ASSURANCE

- A. Solid state LED sources will meet performance specification requirements.
- B. Solid state LED drivers will meet performance specification requirements.
- C. Lamps shall be of the same manufacturer.
- D. Occupancy, vacancy, and daylight responsive sensors shall be certified for operation with specific or driver utilized in controlled luminaires.
- E. Dimming systems shall be certified for operation with specific or driver utilized in controlled luminaires.
- F. Equipment shall be certified for use in the State of the project and shall meet the State Energy Code and local energy ordinances. Comply with governing codes and regulations. Provide products of acceptable manufacturers, which have been in satisfactory use in similar service for

three years. Use experienced installers. Deliver, handle, and store materials in accordance with manufacturer's instructions.

#### 1.4 DEFINITIONS

- A. The term Architect refers to the Architect, Lighting Designer or Owner's Representative individually or collectively.

#### 1.5 GENERAL REQUIREMENTS

- A. Provide all luminaires as shown, complete with all lamps, completely wired, controlled, and securely attached to supports.
- B. Where a catalog number, and a narrative or pictorial description are provided, the written description shall take precedence and prevail.
- C. Contractor shall provide each specified manufacturer with complete information about the luminaires they will supply.
- D. Type of luminaires shall be as indicated alphanumerically and as specified.
- E. Provide luminaires in compliance with applicable Design Lights Consortium and Energy Star Solid State Lighting Luminaires performance requirements as listed in the luminaire schedule with specified color temperature, lumen output, photometrics, and controllability.
  - 1. Base bid manufacturers are listed on the luminaire schedule

#### 1.6 STANDARDS

- A. The Standards and regulated committees referred to in this specification and with which compliance is required are:
  - 1. UL Underwriters Laboratories
  - 2. NEC National Electric Code
  - 3. ANSI American National Standards Institute
  - 4. ASTM American Society of Testing and Materials
  - 5. NEMA National Electrical Manufacturers Association
  - 6. DLC Design Lights Consortium
  - 7. ES Energy Star
- B. All luminaires and assembled components shall be new, of good quality, and be approved by and bear the label of UL or other approved testing agencies, i.e. CSA, ETL, unless otherwise specified in writing.
- C. All luminaires shall meet all required state and/or national building, electrical and energy codes and regulations.

- D. All luminaires and lighting equipment shall comply with related sections of this project's specification, including Divisions 00 Procurement and Contracting Requirements; 01 General Conditions; 26 Electrical Requirements, and 26 09 43 Lighting Controls.

#### 1.7 BIDDING

- A. Follow bidding procedures as describe in General Conditions Sections of this specification.
- B. Provide luminaires in compliance with applicable Design Lights Consortium and Energy Star performance requirements as listed in the luminaire schedule with specified color temperature, lumen output, photometrics, and controllability.

#### 1.8 SUBSTITUTIONS

- A. Substitutions are unacceptable unless the following procedures and requirements are met in order to submit alternate luminaires or manufacturers other than those specified:
- B. Bidders wishing to obtain approval on brands other than those specified by name and catalog number in LUMINAIRE SCHEDULE section of this specification shall submit their requests no later than 2 weeks after the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved as equal to those specified as far as the requirements of the project are concerned.
- C. If the bidder wishes to substitute luminaires from alternate manufacturers, attention is called to Section 2.1, GENERAL MATERIAL REQUIREMENTS of PART 2 PRODUCTS.
- D. In addition, note that the dimensions of visible parts of many luminaires (for example, the aperture diameters of recessed luminaires) are binding to the bidder and cannot be changed without prior approval by the Owner and design team. In addition, all LED luminaires need to meet DLC and ES requirements. Specified luminaires cannot be changed without prior approval by the Owner and design team.
- E. Request for approval shall be accompanied by working luminaire samples (with an appropriate lamp, complete photometric, mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes, as required, to make complete comparison and evaluation. These samples
- F. shall be in addition to those required by Luminaire Specification. The above data shall be delivered separately to the Consultant. The luminaire samples shall be furnished and installed, at the bidder's expense, at a location selected by the Consultant. In addition, the bidder shall furnish the Consultant with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner.
- G. If the bidders do not elect to obtain prior approval during the time so specified, the Owner and design team have no obligation to review or consider any such article after the contract award.

- H. Luminaire details shown may be modified by the manufacturer provided all of the following conditions have been met:
  - 1. Luminaire performance is equal or improved.
  - 2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
  - 3. Cost to the Owner is reduced or equal.
  - 4. Modifications have been reviewed by the Owner and Consultant and been approved in writing.

#### 1.9 SUBMITTALS

- A. Manufacturer's product data sheets for each luminaire indicating luminaire type, dimensions, power supply quantity and type, driver quantity and type, photometric data, material, finishes accessories, voltage, input wattage, CFM data, and photographic image of luminaire.
- B. Manufacturer's data sheet for each power driver including driver type, power factor, input voltage, input watts, and lumen output.
- C. Scaled and dimensioned detail plan and elevation drawings of custom and continuous row type luminaires including joints, mounting points and type, power connection locations(s), and emergency or separate switching configurations.
- D. For custom luminaires, manufacturer shall perform and submit all engineering calculations as required to ensure the safe and proper installation and operation of the luminaire.
- E. Manufacturer's product data sheets for each type of lamp specified, arranged by light source type. Including the following:
  - 1. Wattage
  - 2. Voltage where applicable
  - 3. Rated life
  - 4. Delivered lumen output
  - 5. Correlated Color Temperature
  - 6. Color Rendering Index (CRI)
- F. Manufacturer's data for LED lighting system for each luminaire type. Including:
  - 1. Luminaire dimensions
  - 2. Mounting details
  - 3. Power supply type and maximum remote mounting distance (if applicable)
  - 4. Driver type and maximum remote mounting distance (if applicable)
  - 5. System wiring diagram, differentiating between manufacturer-installed and field-installed wiring
  - 6. Control diagrams
  - 7. Dimming characteristics
- G. The manufacturer shall provide documentation that driver is compatible with dimming systems and equipment with which they are used.

- H. For all submittals under paragraph A through H, manufacturer shall submit within 2 weeks of receipt of order. All submittals shall have project name and luminaire type clearly shown.
  - I. Luminaire shop drawings shall be submitted in quantities and format as described in the General Conditions section of the specifications.
  - J. Contractor shall provide final quantities required for each luminaire type and all necessary accessories.
  - K. The Architect and Consultant shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request supplemental information.
  - L. For each type of Interior Lighting fixture, include the following data:
    - 1. Luminaire cutsheets or other documentation indicating color rendering index (CRI). The following light sources may be excluded: lamps or fixtures specifically designed to provide colored lighting for effect, site lighting, and lamps or fixtures designed for some other special usage.
    - 2. Luminaire cutsheets or other documentation indicating rated life (or L70 for LED sources).
  - M. For each type of lighting fixture purchased for the building and associated grounds within the project boundary, include lamps for both indoor and outdoor fixtures, lamps purchased in nonresidential tenant spaces, as well as both hard-wired and portable fixtures, provide the following data:
    - 1. Luminaire cutsheets or other documentation indicating mean lumen output (design or actual).
- 1.10 MOCK-UPS
- A. It shall be the responsibility of the Contractor to provide a mock-up of the luminaire or lighting systems as indicated in 2.11 LUMINAIRE DESCRIPTION. The mock-up shall be erected within a time period and in a location that is acceptable to the Architect.
  - B. The mock-up installation shall closely conform to the conditions of the actual installation as to:
    - C. height, distance from ceiling, number and type of lamps, material, color, etc. The Contractor shall submit a written description of each proposed mock-up with drawings to obtain the Architect's approval prior to commencement of each mock-up.
    - D. The purpose of the mock-up shall be to study the general appearance and performance of the intended lighting systems. At that time, certain minimal test variations may be requested as to lamp location, lamp type, reflector shape, color, etc. Final modifications, if any, shall be
    - E. considered a part of these Specifications and shall be accomplished with no additional cost to the Owner.

1.11 SAMPLES

- A. It shall be the responsibility of the Contractor to provide a sample(s) luminaire as requested by the Architect or the Consultant. When samples are required, the manufacturer shall provide working samples complete with lamp, driver (rated for 120 Volt operation) and 6' whip with 3prong Edison plug.
- B. The sample shall be provided within three (3) weeks of request.
- C. The sample shall be shipped to a location that is determined by the Architect. Shipping and return shipping costs shall be provided as part of the contract.
- D. The purpose of the sample is to review manufacturing techniques, detailing, lamping and scale. Sample luminaires must be approved prior to fabrication of luminaires for the project. Minor modifications, if any, shall be considered part of these Specifications and shall be accomplished with no additional cost to the Owner.
- E. Sample luminaires shall not be used on the project.

1.12 EXTRA STOCK

- A. Furnish to the Owner, and store at the site where directed, extra stock of each type of luminaire type installed in the Project in quantities as required by Owner, packaged in manufacturer's unopened cartons and identified as to contents by luminaire type.
- B. Furnish items above with appropriate quantity of each exposed trim, fastener, bracket and other items as required for a complete installation.
- C. For the following components, furnish to the Owner extra stock in the quantity specified:
  - 1. Luminaires with user-serviceable internal power supply, driver, and/or transformer: 5% of total for each type, but not fewer than 3 of each type.
  - 2. Luminaires with remote power supply, driver, and/or transformer: 5% of total for each type, but not fewer than 3 of each type.
  - 3. Luminaires with removable lamps supplied by Manufacturer or Contractor: 5% of total for each type, but not fewer than 2 of each type.
  - 4. Luminaires specified with removable accessories (ex: louver, spread lens): 5% of total for each type, but not fewer than 3 of each type.
- D. Furnish to the Owner at least (1) spare driver and LED luminaire of each type.

1.13 WARRANTIES

- A. All luminaires and workmanship shall be guaranteed free of defects and fully operational for a minimum of two years after the acceptance of the project by the Owner. Any luminaires or workmanship found to be defective during the warranty period will be either fixed or replaced by the Contractor at no cost to the Owner.



- B. LED systems and complete luminaires must have manufacturer's warranty of 5 years from date of substantial completion, including chips and drivers.

## PART 2 - PRODUCTS

### 2.1 GENERAL MATERIALS REQUIRMENTS

- A. Ferrous mounting hardware and accessories shall be finished using either a galvanic or phosphate primer/baked paint process to prevent corrosion and discoloration of adjacent materials.
- B. For weatherproof and vaportight installation, painted finishes of luminaires and accessories shall be weatherproof enamel using proper primers or hot dipped galvanized and bonderized epoxy, in accordance with manufacturer's requirements. Unless otherwise specified all painted surfaces shall have a life expectancy of not less than twenty years.
  - 1. Hangers shall be conduit with chemically resistant, weatherproof, baked enamel finish.
  - 2. Where aluminum parts come in contact with bronze parts, apply to both surfaces a coating material to prevent corrosion.
  - 3. Colors shall be as specified in 2.11 LUMINAIRE DESCRIPTION section of this specification.
- C. Fasteners shall be manufactured of non magnetic stainless steel or anodized aluminum, except in indoor applications where galvanized steel shall be acceptable.
- D. Luminaires shall be free of light leaks and shall be designed to provide sufficient ventilation of lamps and ballasts including vent holes where required.
- E. Outdoor luminaires shall have wire mesh corrosion resistant screens in the vent holes.
- F. All sheet metal work shall be free from tool marks and dents and shall have accurate angles bent as sharp as compatible with the gauges of the required metal. All intersections and joints shall be formed true and of adequate strength and structural rigidity to prevent any distortion after assembly. All sheet metal shall be free of light leaks. All edges shall be finished so there are no sharp edges exposed. All miters shall be in accurate alignment with abutting intersecting members. Piecing of plates in individual runs in single planes and the use of spliced pieces or filler material to cover defective workmanship, shall not be acceptable. Sheet metal work shall be properly fabricated so that planes will not deform (i.e. become concave or convex, due to normal expected ambient and operating conditions).
- G. Lampholders shall hold lamps securely against normal vibrations and maintenance handling. Provide solid nickel or nickel and silver plated contacts in lampholders for following types of lamps:
  - 1. Mogul screw base metal halide.
  - 2. Lamps in outdoor fixtures.
- H. Wiring channels shall be rigid and accurately made.

- I. Luminaires that will be installed in or near corrosive environments, including but not limited to swimming pools, shall be approved for use in such spaces by the luminaire manufacturer.
- J. All interior light sources shall have a color rendering index (CRI) of 80 or higher. The following light sources may be excluded: lamps or fixtures specifically designed to provide colored lighting for effect, site lighting, and lamps or fixtures designed for some other special use.
- K. All interior light sources shall have a rate life (or L70 for LED sources) of at least 24,000 hours.
- L. If specified light sources does not meet requirement, notify the Owner for review and approval.

## 2.2 LIGHT SOURCES

- A. Sources shall be as follows unless otherwise noted in 2.11 LUMINAIRE DESCRIPTION:
  - 1. Light Emitting Diodes (LEDs):
    - a. All LEDs shall be batch sorted for color and brightness consistency and shall be manufactured by the same LED manufacturer:
      - 1) Cree
      - 2) Nichia
      - 3) Lumileds
      - 4) Osram/Sylvania
      - 5) Bridgelux
      - 6) Xicato
      - 7) Others as approved by lighting designer.
  - 2. Substitution of LEDs by other manufacturers shall be equal in all respects of initial and maintained lumen output, lamp life, color consistency and compatibility with specified equipment. Substitutions shall be submitted in the form of both manufacturer's printed data and corresponding samples for review
  - 3. Luminaire manufacturers wishing to supply LEDs in their products other than those listed above must verify that the LED manufacturer has been fabricating LEDs for a minimum of five years and obtain prior approval from lighting designer.
  - 4. Dynamic White technology shall be provided where indicated in 2.11 LUMINAIRE
  - 5. DESCRIPTION. Tuning ranges are indicated by correlated color temperature (CCT) range per fixture type and shall be controlled separately from luminaire output.
  - 6. RGB color changing technology shall be provided where indicated in 2.11 LUMINAIRE DESCRIPTION. Color shall be controlled separately from luminaire output.
  - 7. LED lumen output shall be tested in accordance with applicable IESNA LM-79 and
  - 8. LM-80 methods with no more than 30% depreciation in initial lumen output after 50,000+ hours of operation for white LEDs and no more than 50% depreciation in initial lumen output after 30,000+ hours for colored LEDs.
  - 9. LED Drivers: reverse polarity protection, open circuit protection. Minimum 80% efficiency. Class A noise rating.
  - 10. Dimming: LED system capable of continuous dimming to a minimum output as indicated in 2.11 LUMINAIRE DESCRIPTION.
  - 11. All lamps of similar type shall be supplied by the same manufacturer to ensure consistent color and photometric performance.

- B. Life:
  - 1. LED: Rated Life: Tested in accordance with TM-21 standard. L70 rating shall exceed 40,000 hours.

### 2.3 DRIVERS/POWER SUPPLY

- A. LED drivers will also be high efficiency, electronic drivers from well known, reputable manufacturers.
- B. Drivers will have power factors greater than 0.9 and total harmonic distortion less than 10%.
- C. Dimming drivers will be specified in most spaces including those with daylight-responsive controls and multi-scene functionality. They will be specified to dim to 10% light output or less (1% or less in spaces with AV needs) and will be fully compatible with the dimming control equipment.
- D. REFLECTOR CONES
- E. Provide 45° lamp and lamp image cut off unless otherwise specified. In luminaires where upper reflector is separate from cone, cut off shall be 45° unless otherwise specified.
- F. Luminaires in which reflector cones are riveted or welded to housing or where removal of cone requires pressure to be applied to finished surface of reflector shall not be acceptable.
- G. Cone flange shall be formed as an integral part of the cone and shall have identical color and finish as the cone, unless otherwise noted. The flange major surface shall be perpendicular to the cone axis. The width of the flange shall adequately cover the ceiling opening without light leaks. No luminaire parts (housing, mounting frame, etc.) shall be visible between the ceiling surface and the edge of the cone flange. The same requirement shall be applicable to luminaires where main reflector extends down to the bottom edge of the luminaire without a separate cone. In such case, the flange shall be formed as an integral part of the main reflector.
- H. The finish of the inner surface of the reflector shall be specular, semi-specular, or matte as noted in 2.11 LUMINAIRE DESCRIPTION. The reflector inner surface shall be free of water spotting and shall maintain a reflectivity ratio of not less than 83% on clear specular finish. The reflector shall have a low iridescence finish, free from multiple colors seen from normal viewing angles. Colors shall be derived from dyes supplied by Sandoz Chemical Company or approved equal.
- I. The reflecting surface of the cone shall be tested for proper sealing. Test per ASTM B136 63T.
- J. Luminaires with Alzak reflector cones, unless otherwise specified, must be furnished by the same manufacturer.
- K. Reflector cone retention devices shall not deform cone in any manner whatsoever.
- L. Submit a certificate of compliance with Alzak finish requirements with all requests for approval.

## 2.4 LENSES

### A. Glass:

1. Flat glass lenses shall be heat-tempered borosilicate glass unless otherwise noted.
2. Glass finishes, i.e. sandblasting, etching, polishing shall be performed as described in 2.11 LUMINAIRE DESCRIPTION.

### B. Acrylic:

1. Lenses shall be of injection molded crystal clear material 100% virgin acrylic (except as noted). For lenses with male pattern of pyramids or cones, specified minimum thickness refers to distance from flat surface to base of pyramids (cones), or thickness of undisturbed material. For lenses with female pattern, specified minimum thickness refers to overall thickness of material.
2. Lenses shall fully eliminate lamp images when viewed from all directions within the 45° to 90° angle from vertical when the ratio of lamp spacing to the distance from lamp underside to top of lens does not exceed 1.50. Within the viewing angle from 0° to 45° the ratio of maximum brightness (under a lamp) to minimum brightness (between lamps), shall not exceed 3 to 1.
3. Finishes, i.e. sandblasting, etching, polishing shall be performed as described in the 2.11 LUMINAIRE DESCRIPTION.

## 2.5 LOUVERS

### A. Flat Blade:

1. Provide flat blade louvers within formed frame, finish and color as specified.
2. Louvers to provide minimum of 45° cut-off from source image.
3. Blades to be minimum 0.125" thickness unless otherwise specified in 2.11 LUMINAIRE DESCRIPTION.ADJUSTABLE LUMINAIRES

B. In adjustable luminaires, aiming and positive locking devices shall be provided.

C. Luminaires with an adjustable source and using a source with an asymmetrical light pattern shall have an aiming stop which can be permanently set so that the lamp shall remain correctly positioned after service.

## 2.6 LED LUMINAIRES

### A. General:

1. LED light fixtures shall be in accordance with IES, NFPA, UL, as shown on the drawings, and as specified.
2. LED light fixtures shall be Reduction of Hazardous Substances (RoHS)-compliant.
3. LED drivers shall include the following features unless otherwise indicated:
  - a. Minimum efficiency: 85% at full load.
  - b. Minimum Operating Ambient Temperature: -20° C. (-4° F.)
  - c. Input Voltage: 120 - 277V (±10%) at 60 Hz.
  - d. Integral short circuit, open circuit, and overload protection.
  - e. Power Factor: ≥ 0.95.

- f. Total Harmonic Distortion:  $\leq 20\%$ .
- g. Comply with FCC 47 CFR Part 15.
- 4. LED modules shall include the following features unless otherwise indicated:
  - a. Comply with IES LM-79 and LM-80 requirements.
  - b. Minimum CRI 80 and color temperature 3500° K unless otherwise specified in LIGHTING FIXTURE SCHEDULE.
  - c. Minimum Rated Life: 50,000 hours per IES L70.
  - d. Light output lumens as indicated in the LIGHTING FIXTURE SCHEDULE.
- B. Provide LED luminaires as specified in LUMINAIRE SCHEDULE, in compliance with all performance criteria.
- C. Drivers shall be provided by LED luminaire manufacturer and verified to be compatible for successful operation of the specified system. Drivers shall be UL listed independently of the LED luminaire.
- D. LED binning information for specific luminaires shall be fabricated for the project to be provided with shop drawings for specifier approval.
- E. All components to be UL listed as a system unless otherwise submitted for approval.
- F. Housing, LED driver, and LED module shall be products of the same manufacturer unless otherwise specified in 2.11 LUMINAIRE DESCRIPTION.
- G. For continuous runs of luminaires with remote drivers, provide separate power feed for every 8'0" at a maximum to prevent over-heating conditions.
- H. Luminaire shall be equipped with quick-connect connectors for through wiring installation.
- I. For remote driver applications, provide submittals to indicate maximum driver run length distance. Manufacturer shall provide shop drawings including wiring diagram, driver limitations and installation requirements, and mounting details for this application for approval. Incomplete shop drawings will not be evaluated and resubmission will be required with no delay in the order process.
- J. Manufacturer shall provide a warranty of at least 5 years on all parts including but not limited to LED chips and drivers.

## 2.7 WIRING

- A. Voltage Rating:
  - 1. For voltages up to 120 volts, luminaire wiring shall be rated for 300 volts minimum.
  - 2. For voltages above 120 volts, luminaire wiring shall be rated for 600 volts minimum.
- B. Temperature Rating Internal to Luminaire
  - 1. All wiring shall be code approved for luminaire wiring, and shall comply with the following temperature ratings unless luminaire design or local codes require higher temperature wire.

- C. Temperature Rating - External to Luminaire
  - 1. All flexible cord wiring between luminaire components or to electrical receptacle and not in wireways shall have a minimum temperature rating of 105°C.
  - 2. Cord type shall be suitable for application and shall be fitted with proper strain relief and watertight entries where required by application.
- D. Splices
  - 1. Splices internal to luminaire shall be made within separate splice compartments, and shall utilize nylon insulated crimped connections or insulated quick disconnects.
  - 2. Splices to branch circuit wiring in separate junction boxes shall utilize flame retardant thermoplastic caps with fully seated helical metal spring and threaded entry.
- E. No internal wiring shall be visible at normal viewing angles, i.e., above 45° from vertical. Use additional wire clamps if necessary. Anticipate increased visibility if luminaires are mounted on or recessed within a sloping surface.
- F. Any luminaire fed from more than one panel, i.e., for normal and night or emergency operation, shall have separate neutrals to each panel.
- G. Furnish code approved wiring in ceiling cavities forming air plenums.

2.8 LUMINAIRE DESCRIPTION A. See PART 4 – LUMINAIRE SCHEDULE

PART 3 - EXECUTION

3.1 SHIPPING AND STORAGE

- A. All luminaires received at the site shall be stored in clean and dry space until luminaires are installed.
- B. Manufacturer shall clearly mark each box with luminaire designation prior to shipping.
- C. Reflector cones and accessories, including snoots, baffles, louvers, aperture plates, extra lenses and decorative elements of luminaires, shall be packed by the manufacturer separate from the housing (body, stem, etc.) of the luminaire.

3.2 LOCATION

- A. Locations of luminaires are shown diagrammatically. Verify exact location and spacing with Lighting Plans, field conditions, and/or other reference data before ordering of luminaires and during installation. Verify adequacy of clearance with other equipment such as ducts, pipes, conduit, or structural elements. Bring conflicts to Architect's attention before proceeding with work.
- B. Pendant mount, as approved, surface type luminaires where required to meet space conditions.

### 3.3 INSTALLATION

- A. Provide accessories as required for ceiling construction type. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed.
- B. Provide adequate and sturdy support for each luminaire. Contractor shall be responsible for verifying weight and mounting method of all luminaires and furnish and install suitable supports.
- C. Luminaire mounting assemblies shall comply with all local seismic codes and regulations.
- D. Install rows of luminaires accurately on straight lines unless otherwise indicated on drawings. Coordinate with mechanical work.
- E. Luminaires shall be installed free of light leaks, warps, dents, or other irregularities. Light leaks are not acceptable.
- F. Install luminaires with vent holes, free of air blocking obstacles.
- G. Visible hanging devices shall be finished to match the luminaire finish, unless otherwise noted. Suspended luminaires shall hang level and aligned when installed in rows.
- H. Install luminaires in mechanical equipment rooms after ductwork and piping installation. Locate and mount luminaires as indicated on the Drawings unless mechanical equipment prohibits or makes it impractical to do so. In such cases, chain or wall mount luminaires so that serviceable equipment is illuminated.
- I. Where plaster ceilings occur, furnish plaster frames for setting under other applicable sections. Direct the setting and be responsible for correct location; Ensure the bottom of frame is flush with finished ceiling, forming screed edge for finished plaster.
  - 1. Luminaires shall be supported by plaster frames utilizing yokes or leveling lugs.
  - 2. Luminaires and support elements shall not be mounted to or in contact with ducts or pipes.
  - 3. Yoke shall have channel cross section of sufficient gauge, and shall support a luminaire by means of not fewer than two (2) bolts each.
  - 4. If air diffusers are located in common continuous rows with luminaires in plaster ceilings, furnish plaster frames of proper length to accommodate diffusers.
  - 5. Luminaires recessed in ceilings which have a fire-resistive rating of one hour or more shall be enclosed in a box which has a fire-resistive rating equal to that of the ceiling.
- J. Contractor shall be responsible for adjusting aperture rings on all ceiling recessed luminaires to accommodate various ceiling material thickness. Contractor shall be responsible for coordinating the cut-out size in ceiling to ensure aperture covers cut-out entirely. The bottom of aperture rings shall be flush with finished ceiling or not more than 1/16" above. Under no circumstances will the aperture ring extend below the finished ceiling surface.



- K. For luminaires with variable position lampholder assemblies, Contractor shall confirm prior to installation proper lampholder (socket) position in field, shall align lampholders in visually contiguous spaces, and shall adjust, if necessary, after coordination with manufacturer.
- L. For wallwash luminaires, orient reflector to properly illuminate the focal wall. For adjustable luminaires, aim downward or in accordance with aiming diagram provided by designer.
- M. Surface-Mounted Luminaires: Support surface-mounted luminaires from structural members other than ceiling tees.
- N. Pendant-Mounted Luminaires:
  - 1. Pendant-mounted luminaires shall be supported from structural framework of ceiling or from inserts cast into slab.
  - 2. All pendants shall have swivel aligners located at the top ends; pendants shall be 1/2" rigid steel conduit unless specifically indicated otherwise on drawings or in specifications.
  - 3. All pendant and surface-mounted luminaires shall be supported with two (2) supports per four foot section or three (3) per eight foot section.
- O. Bracket-Mounted Luminaires:
  - 1. For each bracket luminaire, provide flanged metal stem attached to outlet box, with threaded end suitable for supporting the luminaire rigidly in design position.
  - 2. Flanged part of luminaire stud shall be of broad base type, secured to outlet box at not fewer than three (3) points.
- P. Mask the trims and bottoms of all luminaires if necessary to protect the luminaire during construction. At the completion of construction, clean the bottoms, the trim, the reflecting surfaces, lenses, baffles, louvers, and reflector cones of all luminaires so as to render them free of any material, substance, or film foreign to the luminaire. If the luminaires are deemed dirty by the Owner at the completion of the project, the Contractor shall clean them at no additional cost to the Owner. Luminaire components whose finishes are damaged shall be replaced at no cost to the Owner. Use only water and dust-cloths to clean Alzak reflectors: the use of any chemical cleaning agent will permanently damage the reflector and require replacement.
- Q. Immediately prior to occupancy clean reflectors, reflector cones, aperture plates, lenses, trim rings, faceplates, louvers, lamps and decorative elements.
- R. Provide labor and materials for final aiming of all adjustable luminaires under the Consultant's supervision. Aiming shall take place immediately before building is turned over to Owner, after regular working hours, where required. Contractor shall have all tools, ladders, and equipment for accessing each luminaire as well as complete stock of lenses, spare lamps, and ballasts, as required by this specification.

PART 4 - LUMINAIRE SCHEDULE

Type	Mounting	Description	Lamping	Manufacturer & Model	Remarks
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ADO1 Recessed Downlight	Ceiling, Recessed	Nominal Aperture: 4" Round Nominal Size: 11 3/16"W x 9 7/16"L x 5 11/16"H Optics: Diffuse Lens Trim Style: Overlap Flange Reflector: Semi-specular Finish: White Housing: Steel Driver: Dimming, 0-10V, 10%	Wattage: 8.5 Lumens Delivered: 706.02 Type: LED Module Color Temp: 4000K Min CRI: 80	Mfr: Lithonia Series: LDN4 Model: LDN4 40/05 L04 TBD LS MVOLT GZ10 TRW  Alt Mfr: Liton, Lightolier	Must be same manufac- turer as ADO2, AW01, and AW02, Emergency where re- quired. Contractor to review mounting condition for each location and ensure compatibility.
ADO2 Cylinder Downlight	Ceiling, Suspended	Nominal Aperture: 4" Round Nominal Size: 6 1/8"D x 10 13/16"H Optics: Diffuse Lens Trim Style: Canopy at J-box Reflector: Semi-specular Finish: White Housing: Die-cast Aluminum Driver: Dimming, 0-10V, 10%	Wattage: 8.5 Lumens Delivered: 706.02 Type: LED Module Color Temp: 4000K Min CRI: 80	Mfr: Lithonia Series: LDN4 Cylinder Model: LDN4CYL 40/05 L04 TBD LS MVOLT GZ10 TBD  Alt Mfr: Liton, Lightolier	Suspension length as indicated in model. Pro- vide with extended sus- pension where neces- sary. Must be same manufac- turer as ADO1, AW01, and AW02, Emergency where re- quired. Contractor to review mounting condition for each location and ensure compatibility.
AF01 Troffer	Ceiling, Recessed	Nominal Aperture: 24"W x 24"L Nominal Size: 24"W x 24"L x 3 11/16"H Optics: Diffuser Trim Style: Overlap Flange Reflector: White Finish: White Housing: Cold-rolled Steel Driver: Dimming, 0-10V, 10%	Wattage: 29 Lumens Delivered: 3,327.8 Type: LED Module Color Temp: 4000K Min CRI: 82	Mfr: Lithonia Series: 2ALL Model: 2ALL2-33L-GZ10- LP840  Alt Mfr: Dayolite, Litecon- trol	Contractor to confirm mounting hardware is compatible with ceiling specification. Emergency where re- quired.
AG01 Linear Wrap	Wall, Surface	Nominal Aperture: 8" Linear Nominal Size: 4.374"w x Lengths x 4.5"H Optics: Prismatic Lens Trim Style: Canopy at J-box Reflector: White Finish: White Housing: Die Form Steel Driver: Dimming, 0-10V, 10%	Wattage: 5W/ft Lumens Delivered: 480 Type: LED Board Color Temp: 4000K Min CRI: 90	Mfr: Coronet Series: HP LED Model: HP LED Length 40 LTG1 UNV DB W WM  Alt Mfr: Dayolite, Litecon- trol	Lengths as shown on drawings. Emergency where re- quired.
AG02 Linear Wallwash	Wall, Surface	Nominal Aperture: 2" Linear Nominal Size: 1 5/8"w x Lengths x 4 7/8"H Optics: Extruded Acrylic Trim Style: Canopy at J-box Reflector: N/A Finish: White Housing: Extruded Aluminum Driver: Dimming, 0-10V, 10%	Wattage: 4.6W/ft Lumens Delivered: 469 Type: LED Board Color Temp: 4000K Min CRI: 90	Mfr: Prudential Ltg Series: MicroWash Model: MW LED4 LO Rxx TMW SC UNV SUR X3 DM10  Alt Mfr: Vode, Lumium	Lengths as shown on drawings. Manufacturer to provide shop drawings of continuous lengths for approval.
AG03 Not used					

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APO1 Linear Direct- only Pen- dant	Ceiling, Suspended	Nominal Aperture: 5" Linear Nominal Size: 5.27"W x Lengths x 4.01"H Optics: Wide Diffuse Lens Suspension Style: Aircraft Cable Reflector: White Finish: White Housing: Cold-rolled Steel Driver: Dimming, 0-10V, 10%	Wattage: 5.195W/ft Lumens Delivered: 727lm/ft Type: LED Board Color Temp: 4000K Min CRI: 80	Mfr: Lithonia Series: CLX LED Linear Model: CLX Lxx 3000LM (per 4ft) HEF WDL WD MVOLT GZ10 40K 80CRI  Alt Mfr: Cree, HE Williams	Lengths as shown on drawings. Luminaires do not need to be continu- ous. Emergency where re- quired. Luminaires to be mount- ed 8'-0"AFF
APO1A Linear Direct- only Pen- dant	Ceiling, Suspended	Nominal Aperture: 5" Linear Nominal Size: 5.27"W x 8'-0" x 4.01"H Optics: Wide Diffuse Lens Suspension Style: Aircraft Cable Reflector: White Finish: White Housing: Cold-rolled Steel Driver: Dimming, 0-10V, 10%	Wattage: 135W Lumens Delivered: 18000 lm Type: LED Board Color Temp: 4000K Min CRI: 80	Mfr: Lithonia Series: CLX LED Linear Model: CLX L96 18000LM HEF WDL WD MVOLT GZ10 40K 80CRI  Alt Mfr: Cree, HE Williams	Lengths as shown on drawings. Luminaires do not need to be continu- ous. Emergency where re- quired. Luminaires to be mount- ed such that they do not obstruct any activities below.
APO2 Linear Direct- Indirect Pendant	Ceiling, Suspended	Nominal Aperture: 3" Linear Nominal Size: 7"W x Lengths x 2"H Optics: Satin Acrylic Lens Suspension Style: Aircraft Cable Reflector: White Finish: White Housing: Cold-rolled Steel Driver: Dimming, 0-10V, 10%	Wattage: 13W/ft Lumens Delivered: 1290 Type: LED Board Color Temp: 4000K Min CRI: 90	Mfr: Coronet Series: ECO LED Model: ECO LED X' 40 LTG3 UNV DB W AC  Alt Mfr: Dayolite, Litecon- trol	Lengths as shown on drawings. Emergency where re- quired.
ASO1 Recessed Linear Slot	Ceiling, Recessed	Nominal Aperture: 3" Linear Nominal Size: 3.4375"W x Lengths x 10"H Optics: Satin Acrylic Lens Trim Style: Overlap Flange Reflector: White Finish: White Housing: Extruded Aluminum Driver: Dimming, 0-10V, 10%	Wattage: 5W/ft Lumens Delivered: 450lm/ft Type: LED Board Color Temp: 4000K Min CRI: 90	Mfr: Coronet Series: PG4 LED Model: PG4 LED xx 40 LTG2 UNV DB W TBD 4"  Alt Mfr: Dayolite, Litecon- trol	Luminaire to be provided in continuous wall-to-wall lengths, to be verified in field. Lamping to be held off 6" to 12" on both ends of luminaire to minimize hotspots. Contractor to confirm mounting hardware is compatible with ceiling specification.
AUO1 Linear Uplight	Wall, Surface	Nominal Aperture: 6" Linear Nominal Size: 8 5/8"W x Lengths x 5 1/8"H Optics: Asymmetric, Clear Acryl- ic Lens Trim Style: Canopy at J-box Reflector: White Finish: TBD Housing: Extruded Aluminum Driver: Dimming, 0-10V, 10%	Wattage: 82W/8ft Lumens Delivered: 8886 Type: LED Board Color Temp: 4000K Min CRI: 82	Mfr: Winona Series: 801s Windirect Model: WLAWC801S SSY1 INT xxLONG AL1AH1 40K MVOLT CA TBD  Alt Mfr: Eliptipar	Luminaire runs to be provided by continuous mounting of individual fixtures. Preferably (4) 8ft luminaires. Contrac- tor to verify mounting location in field and confirm fixture lengths to be used with Lighting Designer. Emergency where re- quired.
AUO2 Linear Uplight	Wall, Surface	Nominal Aperture: 6" Linear Nominal Size: 8 5/8"W x Lengths x 5 1/8"H Optics: Asymmetric, Clear Acryl- ic Lens Trim Style: Canopy at J-box Reflector: WhiteFinish: TBD Housing: Extruded Aluminum Driver: Dimming, 0-10V, 10%	Wattage: 40W/8ft Lumens Delivered: 4664 Type: LED Board Color Temp: 4000K Min CRI: 82	Mfr: Winona Series: 801s Windirect Model: WLAWC801S SSY1 INT xxLONG AL1AN1 40K MVOLT TBD CA TBD  Alt Mfr: Eliptipar	Luminaire runs to be provided by continuous mounting of individual fixtures. Preferably (4) 8ft luminaires. Contrac- tor to verify mounting location in field and confirm fixture lengths to be used with Lighting Designer. Emergency where re- quired.

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AU03 Linear Uplight	Wall, Recessed	Nominal Aperture: 4" Linear Nominal Size: 4"D x 96"L Optics: Asymmetric Throw Trim Style: Canopy at J-box Reflector: White Finish: TBD Housing: Extruded Aluminum Driver: Dimming, 0-10V, 0.1%	Wattage: 36 Lumens Delivered: 2360 Type: LED Board Color Temp: 4000K Min CRI: 81	Mfr: Peerless Series: RD4W1 Model: RD4W1 LSL 8FT MSL8 80CRI 40K 1300LMF DARK ZT TBD SCT TBD  Alt Mfr: Axis*, Lumium*	*Acceptable alternates do not require round profile, but do require asymmetric throw. Emergency where required.
AW01 Recessed Wallwash	Ceiling, Recessed	Nominal Aperture: 4" Round Nominal Size: 11 3/16"W x 9 7/16"L x 5 11/16"H Optics: Diffuse Lens Trim Style: Overlap Flange Reflector: Semi-specular Finish: White Housing: Steel Driver: Dimming, 0-10V, 10%	Wattage: 8.5 Lumens Delivered: 706.2 Type: LED Module Color Temp: 4000K Min CRI: 80	Mfr: Lithonia Series: LDN4 Model: LDN4 40/10 LW4 AR LSS MVOLT GZ10 TRW  Alt Mfr: Liton, Lightolier	Emergency where required.
AW02 Wallwash Cylinder	Ceiling, Suspended	Nominal Aperture: 4" Round Nominal Size: 6 1/8"D x 10 13/16"H Optics: Diffuse Lens Trim Style: Canopy at J-box Reflector: Semi-specular Finish: White Housing: Die-cast Aluminum Driver: Dimming, 0-10V, 10%	Wattage: 8.5 Lumens Delivered: 706.2 Type: LED Module Color Temp: 4000K Min CRI: 80	Mfr: Lithonia Series: LDN4 Cylinder Model: LDN4CYL 40/10 LW4 AR LSS MVOLT GZ10 TBD  Alt Mfr: Liton, Lightolier	Suspension length as indicated in model. Provide with extended suspension where necessary. Emergency where required.
AZ01 Circular Indirect Pendant	Ceiling, Suspended	Nominal Aperture: 36"D x 3"H Nominal Size: 36"D x 3"H Optics: Frosted Acrylic Diffuser Suspension Style: Aircraft Cable Reflector: White Finish: TBD Housing: Extruded Aluminum Driver: Dimming, 0-10V, 10%	Wattage: 39 Lumens Delivered: 3250 Type: LED Board Color Temp: 4000K Min CRI: 90	Mfr: Delray Series: UNO Model: UIC3 TBD W40 S D  Alt Mfr: Prudential, Dayo- lite	Emergency where required.

END OF SECTION 265100

## SECTION 265200 EMERGENCY LIGHTING

### PART 1 GENERAL

#### 1.1 SECTION INCLUDES

- A. Emergency lighting units.
- B. Exit signs.
- C. Fluorescent and LED Driver emergency power supply units.
- D. Lamps.
- E. Luminaire accessories.

#### 1.2 RELATED REQUIREMENTS

- A. Section 26 0537 - Boxes.
- B. Section 26 0553 - Identification for Electrical Systems: Identification products and requirements.
- C. Section 26 0923 - Lighting Control Devices: Automatic controls for lighting including occupancy sensors, outdoor motion sensors, time switches, outdoor photo controls, and daylighting controls.
- D. Section 26 2726 - Wiring Devices: Manual wall switches and wall dimmers.
- E. Lighting Fixture Schedule as indicated on drawings.

#### 1.3 REFERENCE STANDARDS

- A. 47 CFR 15 - Radio Frequency Devices; current edition.
- B. IESNA LM-63 - ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information; 2002 (Reaffirmed 2008).
- C. IES LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products; 2008.
- D. IES LM-80 - Approved Method: Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays, and Modules; 2015.
- E. NECA 1 - Standard for Good Workmanship in Electrical Construction; 2015.
- F. NECA/IESNA 500 - Standard for Installing Indoor Commercial Lighting Systems; 2006.

- G. NECA/IESNA 502 - Standard for Installing Industrial Lighting Systems; 2006.
- H. NEMA 410 - Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts; 2015.
- I. NEMA LE 4 - Recessed Luminaires, Ceiling Compatibility; 2012.
- J. UL 924 Emergency Lighting and Power Equipment; Current Edition, Including All Revisions.
- K. UL 1598 - Luminaires; Current Edition, Including All Revisions.
- L. UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products; Current Edition, Including All Revisions.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Coordinate the installation of luminaires with mounting surfaces installed under other sections or by others. Coordinate the work with placement of supports, anchors, etc. required for mounting. Coordinate compatibility of luminaires and associated trims with mounting surfaces at installed locations.
  - 2. Coordinate the placement of luminaires with structural members, ductwork, piping, equipment, diffusers, fire suppression system components, and other potential conflicts installed under other sections or by others.
  - 3. Coordinate placement of exit signs with furniture, equipment, signage or other potential obstructions to visibility, installed by other sections or others.
  - 4. Notify Architect of any conflicts or deviations from the contract documents to obtain direction prior to proceeding with work.

#### 1.5 SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Shop Drawings:
  - 1. Indicate dimensions and components for each luminaire of the manufacturer.
  - 2. Provide photometric calculations where luminaires are proposed for substitution upon request.
- C. Shop Drawings: For nonstandard or custom luminaires.
  - 1. Include plans, elevations, sections, and mounting and attachment details.
  - 2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 3. Include diagrams for power, signal, and control wiring.

- D. Product Data: Provide manufacturer's standard catalog pages and data sheets including detailed information on luminaire construction, dimensions, ratings, finishes, mounting requirements, listings, service conditions, photometric performance, installed accessories, and ceiling compatibility; include model number nomenclature clearly marked with all proposed features.
1. Arrange in order of luminaire designation.
  2. Include data on features, accessories, and finishes.
  3. Include physical description and dimensions of luminaires.
  4. Include life, output (lumens, CCT, and CRI), and energy efficiency data.
  5. Photometric data and adjustment factors based on laboratory tests, complying with IESNA LM-79 and IESNA LM-80.
    - a. Manufacturers' Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
    - b. Testing Agency Certified Data: Photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
    - c. TM-21 report for L70 rating at color temperature specified.
  6. Ballasts/drivers: Include wiring diagrams and list of compatible lamp configurations.
  7. Lamps/LED arrays: Include rated life, color temperature, color rendering index (CRI), and initial and mean lumen output.
- E. Sustainable Design Documentation: Submit manufacturer's product data on lamp mercury content and rated lamp life, showing compliance with specified requirements.
- F. Samples:
1. Provide one sample(s) of each specified luminaire upon request.
  2. Provide one sample(s) of each custom luminaire.
  3. Provide one sample(s) of each luminaire proposed for substitution upon request.
  4. Provide one sample(s) of each product finish illustrating color and texture upon request.
  5. Provide a mockup of selected luminaires upon request.
  6. Submit two color chips 3 x 3 inch in size illustrating luminaire finish color where indicated in luminaire schedule.
- G. Certificates for Dimming Ballasts/Drivers: Manufacturer's documentation of compatibility with dimming controls to be installed.
- H. Field quality control reports.
- I. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency. Include instructions for storage, handling, protection, examination, preparation, and installation of product.

- J. Operation and Maintenance Data: Instructions for each product including information on replacement parts.

#### 1.6 EXTRA PRODUCTS

- A. Provide 2 emergency lighting units complete with all labor and materials required for installation as directed by the Local Authority Having Jurisdiction.
- B. Provide 2 universal exit signs complete with all labor and materials required for installation as directed by the Local Authority Having Jurisdiction.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
  - 1. See Division 01 – General Requirements.
  - 2. Extra Lenses and Louvers: Two percent of total quantity installed for each type, but not less than one of each type.
  - 3. Extra Lamps: Ten percent of total quantity installed for each type, but not less than two of each type.
  - 4. 2
  - 5. LED Drivers: Furnish two of each driver type
  - 6. Furnish 1 replacement battery for each battery type and size.
- D. Project Record Documents: Record actual connections and locations of luminaires and any associated remote components.

#### 1.7 QUALITY ASSURANCE

- A. Conform to requirements of NFPA 70.
- B. Maintain at the project site a copy of each referenced document that prescribes execution requirements.
- C. Manufacturer Qualifications: Company specializing in manufacturing the products specified in this section with minimum three years documented experience.
- D. Product Listing Organization Qualifications: An organization recognized by OSHA as a Nationally Recognized Testing Laboratory (NRTL) and acceptable to authorities having jurisdiction.

#### 1.8 QUALIFICATION DATA: For testing laboratory providing photometric data for luminaires.

- A. Seismic Qualification Certificates: For luminaires, accessories, and components, from manufacturer.
  - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.



- B. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

#### 1.9 DELIVERY, STORAGE, AND PROTECTION

- A. Receive, handle, and store products according to NECA/IESNA 500 (commercial lighting), NECA/IESNA 502 (industrial lighting), and manufacturer's written instructions.
- B. Keep products in original manufacturer's packaging and protect from damage until ready for installation.

#### 1.10 FIELD CONDITIONS

- A. Maintain field conditions within the manufacturers required service conditions during and after installation.

#### 1.11 WARRANTY

- A. See Division 01 – General Requirements.
- B. Section 26 0400 – General Requirements for Electrical Trades.
- C. Unless otherwise noted in Lighting Fixture Schedule, Provide three year manufacturer warranty for all LED luminaires, including drivers.
- D. Provide five year manufacturer warranty for batteries for emergency lighting units.
- E. Provide ten year manufacturer warranty for batteries for self-powered exit signs.
- F. Provide five year manufacturer warranty for fluorescent and LED Driver emergency power supply units.

### PART 2 PRODUCTS

#### 2.1 LUMINAIRE TYPES

- A. Furnish products as indicated in Lighting Fixture Schedule included on the drawings.
- B. Substitutions: See Division 01- General Requirements, except where individual luminaire types are designated with substitutions not permitted and the following:
  - 1. Section 26 04 00 – Product Requirements and as follows:
    - a. Approved equals to the basis of design fixture as listed in the Lighting Fixture Schedule shall be accepted for review with the proposed substitute fixture meeting the following minimum requirements:

- 1) Be of the same general size, style and shape, including but not limited to lens construction and shading.
  - 2) Be of equal or better quality and construction.
  - 3) Be supplied with all required accessories to match the specified fixture.
  - 4) Be supplied with all remote drivers, power supplies and cabling lengths to meet specified performance and control.
  - 5) Provide the same or better distribution, efficiency, source lumen output, and L70 lumen depreciation metric.
- b. Provide point by point photometric calculations at the request of the Engineer for evaluation.
  - c. The basis of design fixture listed in the Lighting Fixture Schedule lists part numbers, specifications, options, accessories and source output available at the time of design. Substitutions shall meet these requirements as scheduled.
  - d. The evaluation of an approved equal shall be at the sole discretion of the Architect and Engineer.

## 2.2 EMERGENCY LIGHTING UNITS

- A. Manufacturers:
  1. Manufacturers represented by Apex Lighting.
  2. Manufacturers represented by Lighting Affiliates.
  3. Manufacturers represented by Illuminate/Vanguard Lighting.
  4. Manufacturers represented by Reflex Lighting.
  5. Substitutions: See paragraph 2.1, B.
- B. Emergency lighting units complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- C. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps/LED arrays to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- D. Battery:
  1. Sealed maintenance free lead calcium unless otherwise indicated.
  2. Size battery to supply all connected lamps/LED arrays, including emergency remote heads where indicated.
- E. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
- F. Provide low voltage disconnect to prevent battery damage from deep discharge.

- G. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.

## 2.3 EXIT SIGNS

- A. Manufacturers:
  - 1. Manufacturers represented by Apex Lighting.
  - 2. Manufacturers represented by Lighting Affiliates.
  - 3. Manufacturers represented by Illuminate/Vanguard Lighting.
  - 4. Manufacturers represented by Reflex Lighting.
  - 5. Substitutions: See paragraph 2.1, B.
- B. Description: Internally illuminated exit signs with LEDs unless otherwise indicated; complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
  - 1. Number of Faces: Single or double as indicated or as required for the installed location.
  - 2. Directional Arrows: Universal type for field adjustment sized so that they are clearly visible at a distance of 40 feet as required by local codes.
  - 3. Mounting: Wall, ceiling or pendant as indicated. Provide universal mount exit signs where indicated.
  - 4. Housing: Varies, refer to Lighting Fixture Schedule.
  - 5. Face: Varies, refer to Lighting Fixture Schedule.
- C. Self-Powered Exit Signs:
  - 1. Product Description: UL 924 self-contained emergency lighting unit.
  - 2. Operation: Upon interruption of normal power source or brownout condition exceeding 20 percent voltage drop from nominal, solid-state control automatically switches connected lamps to integral battery power for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
  - 3. Battery: Sealed maintenance-free nickel cadmium unless otherwise indicated.
  - 4. Diagnostics: Provide power status indicator light and accessible integral test switch to manually activate emergency operation.
  - 5. Provide low-voltage disconnect to prevent battery damage from deep discharge.
  - 6. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status.
- D. Special Wording Signs: Provide with special wording as indicated.
  - 1. Where indicated, provide with international symbol of accessibility complying with state and local codes.
  - 2. Provide combination exit/special wording signs where indicated.
- E. Accessories:
  - 1. Provide compatible accessory high impact polycarbonate vandal shields where indicated.

2. Provide compatible accessory wire guards where indicated.

## 2.4 MATERIALS

### A. Parts:

1. Free of burrs and sharp corners and edges.
2. Sheet metal components shall be steel unless otherwise indicated.
3. Form and support to prevent warping and sagging.
4. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
5. Diffusers and Globes:
  - a. Refer to Interior Lighting Fixture Schedule for types.
  - b. Acrylic Diffusers: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
  - c. Glass: Annealed crystal glass unless otherwise indicated.
  - d. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
6. Housings:
  - a. Extruded-aluminum housing and heat sink unless otherwise indicated.
  - b. Powder-coat finish unless otherwise indicated, color selection by Architect.
7. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Locate labels where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
  - a. Label shall include the following lamp characteristics:
    - 1) "USE ONLY" and include specific lamp type.
    - 2) Lamp diameter, shape, size, wattage, and coating.
    - 3) CCT and CRI for all luminaires.

### B. METAL FINISHES

1. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

## 2.5 FLUORESCENT AND LED DRIVER EMERGENCY POWER SUPPLY UNITS

### A. Manufacturers:

1. Manufacturers represented by Apex Lighting.
2. Manufacturers represented by Lighting Affiliates.
3. Manufacturers represented by Illuminate/Vanguard Lighting.
4. Manufacturers represented by Reflex Lighting.
5. Substitutions: See paragraph 2.1, B.
6. Manufacturer Limitations: Where possible, for each type of luminaire provide emergency power supply units produced by a single manufacturer.

7. Where a specific manufacturer or model is indicated elsewhere in the light fixture schedule or on the drawings, it is listed to be compatible with the basis of design light fixture. Provide compatible model, with equal or greater lumen output, for the light fixture provided.
- B. Description: Self-contained emergency power supply units suitable for use with indicated luminaires, complying with NFPA 101 and all applicable state and local codes, and listed and labeled as complying with UL 924.
- C. Compatibility:
  1. Ballasts: Compatible with electronic, standard magnetic, energy saving, and dimming AC ballasts, including those with end of lamp life shutdown circuits.
  2. Lamps: Compatible with low-mercury lamps.
  3. LED Drivers: Compatible with LED driver and LED arrays.
- D. Operation: Upon interruption of normal power source, solid-state control automatically switches connected lamp(s)/LED arrays to the emergency power supply for minimum of 90 minutes of rated emergency illumination, and automatically recharges battery upon restoration of normal power source.
- E. Battery: Sealed maintenance-free high-temperature nickel cadmium unless otherwise indicated.
- F. Emergency Illumination Output: Refer to Lighting Fixture Schedule and drawings.
- G. Diagnostics: Provide accessible and visible multi-chromatic combination test switch/indicator light to display charge, test, and diagnostic status and to manually activate emergency operation.
- H. Self-Diagnostics: Provide units that self-monitor functionality and automatically perform testing required by NFPA 101 where indicated; provide indicator light(s) to report test and diagnostic status and field selectable audible alert.
- I. Operating Temperature: From 32 degrees F (0 degrees C) to 122 degrees F (50 degrees C) unless otherwise indicated or required for the installed location.
- J. Accessories:
  1. Where not integral to fixture, provide compatible accessory remote combination test switch/indicator light mounted on ceiling adjacent to unit or as indicated.

## 2.6 LUMINAIRE FIXTURE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 “Hangers and Supports for Electrical Systems” for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with heavy duty swivel ball fittings and ceiling canopy. Finish same as luminaire.

- C. Wires: ASTM A 641/A 641 M, Class 3, soft temper, zinc-coated steel, 12 gage minimum.
- D. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.
- F. Provide accessory plaster frames for luminaires recessed in plaster ceilings.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Verify that field measurements are as shown on the drawings.
- B. Verify that outlet boxes are installed in proper locations and at proper mounting heights and are properly sized to accommodate conductors in accordance with NFPA 70.
- C. Verify that suitable support frames are installed where required.
- D. Verify that branch circuit wiring installation is completed, tested, and ready for connection to luminaires.
- E. Verify that conditions are satisfactory for installation prior to starting work.

#### 3.2 PREPARATION

- A. Provide extension rings to bring outlet boxes flush with finished surface.
- B. Clean dirt, debris, plaster, and other foreign materials from outlet boxes.

#### 3.3 INSTALLATION

- A. Coordinate locations of outlet boxes provided under Section 26 0533 as required for installation of luminaires, emergency lighting units and exit signs provided under this section.
- B. Perform work in accordance with NECA 1 (general workmanship).
- C. Install products in accordance with manufacturer's instructions.
- D. Install luminaires securely, in a neat and workmanlike manner, as specified in NECA 500 (commercial lighting) and NECA 502 (industrial lighting).
- E. Install luminaires plumb and square and aligned with building lines and with adjacent luminaires.

- F. Suspended Ceiling Mounted Luminaires:
1. Do not use ceiling tiles to bear weight of luminaires.
  2. Do not use ceiling support system to bear weight of luminaires unless ceiling support system is certified as suitable to do so.
  3. Secure surface-mounted and recessed luminaires to ceiling support channels or framing members or to building structure.
  4. Secure pendant-mounted luminaires to building structure.
    - a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  5. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box, heavy-duty swivel hangers and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
  6. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
  7. In addition to ceiling support wires, provide two galvanized steel safety wire(s), minimum 12 gage, connected from opposing corners of each recessed luminaire to building structure.
  8. See Division 09 - Finishes where suspended grid ceiling is specified for additional requirements.
- G. Recessed Luminaires:
1. Install trims tight to mounting surface with no visible light leakage.
  2. Secure lay-in luminaires to ceiling support channels using listed safety clips at four corners.
  3. Non-IC Rated Luminaires: Maintain required separation from insulation and combustible materials according to listing.
  4. Luminaires Recessed in Fire-Rated Ceilings: Install using accessories and firestopping materials to meet regulatory requirements for fire rating.
  5. Install recessed luminaires to permit removal from below.
- H. Suspended Luminaires:
1. Unless otherwise indicated, specified mounting heights are to bottom of luminaire.
  2. Install using the suspension method indicated, with support lengths and accessories as required for specified mounting height.
  3. Provide minimum of two supports for each luminaire equal to or exceeding 4 feet nominal length, with no more than 4 feet (1.2 m) between supports.
  4. Install canopies tight to mounting surface.
  5. Secure pendant-mounted luminaires to building structure.
    - a. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  6. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box, heavy-duty swivel hangers and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.

7. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and wire support for suspension for each unit length of luminaire chassis, including one at each end.
  8. Unless otherwise indicated, support pendants from swivel hangers.
- I. Wall-Mounted Luminaires: Unless otherwise indicated, specified mounting heights are to center of luminaire.
- J. Install accessories furnished with each luminaire.
- K. Bond products and metal accessories to branch circuit equipment grounding conductor.
- L. Emergency Lighting Units:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
  2. Install lock-on device on branch circuit breaker serving units.
  3. Install plumb and adjust to align with building lines and with each other. Secure to prevent movement.
- M. Exit Signs:
1. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal lighting in same room or area. Bypass local switches, contactors, or other lighting controls.
  2. Install lock-on device on branch circuit breaker serving units.
  3. Install plumb and adjust to align with building lines and with each other. Secure to prevent movement.
  4. Install suspended exit signs using pendants from swivel hangers. Install pendant lengths required to suspend sign at height indicated or as instructed by the Authority Having Jurisdiction.
- N. Fluorescent and LED Driver Emergency Power Supply Units:
1. For field-installed units, install inside luminaire unless otherwise indicated. Where installation inside luminaire is not possible, install on top of luminaire.
  2. Unless otherwise indicated, connect unit to unswitched power from same circuit feeding normal ballast(s)/driver(s) in luminaire. Bypass local switches, contactors, or other lighting controls.
  3. Install lock-on device on branch circuit breaker serving units.
- O. Install specified lamps in each luminaire.
- P. Lamp Burn-In: Operate lamps at full output for prescribed period per manufacturer's recommendations prior to use with any dimming controls. Replace lamps that fail prematurely due to improper lamp burn-in.
- Q. Install accessories furnished with each luminaire.



- R. Connect luminaires to branch circuit using flexible conduit, except for emergency lighting which shall be in conduit completely.
- S. Make wiring connections to branch circuit using building wire with insulation suitable for temperature conditions within luminaire.
- T. Ground and bond interior luminaires in accordance with Section 26 05 26.

#### 3.4 FIELD QUALITY CONTROL

- A. See Division 01 – General Requirements.
- B. Inspect each product for damage and defects.
- C. Operate each luminaire after installation and connection to verify proper operation.
- D. Test self-powered exit signs, emergency lighting units, and emergency power supply units to verify proper operation upon loss of normal power supply.
- E. Correct wiring deficiencies and repair or replace damaged or defective products. Repair or replace excessively noisy ballasts as determined by Architect.

#### 3.5 ADJUSTING

- A. Aim and position adjustable emergency lighting unit lamps to achieve optimum illumination of egress path as required or as directed by Architect or authority having jurisdiction.
- B. Exit Signs with Field-Selectable Directional Arrows: Set as indicated or as required to properly designate egress path as directed by Architect or authority having jurisdiction.

#### 3.6 CLEANING

- A. Clean surfaces according to NECA 500 (commercial lighting), NECA 502 (industrial lighting), and manufacturer's instructions to remove dirt, fingerprints, paint, or other foreign material and restore finishes to match original factory finish.
- B. Clean photometric surfaces as recommended by the manufacturer.

#### 3.7 CLOSEOUT ACTIVITIES

- A. See Division 01- General Requirements
- B. Demonstration: Demonstrate proper operation of luminaires to Architect, and correct deficiencies or make adjustments as directed.
- C. Just prior to Substantial Completion, replace all lamps that have failed.

3.8 PROTECTION

- A. Protect installed luminaires from subsequent construction operations.

END OF SECTION 265200

SECTION 265600 – OUTDOOR ARCHITECTURAL LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All luminaires and lighting equipment shall comply with related sections of this project's specification, including Divisions 00 Procurement and Contracting Requirements; 01 General Conditions; 26 Electrical Requirements, 26 09 23 Lighting Controls, and 26 51 00 Interior Lighting.

1.2 SUMMARY

- A. Section Includes:
  - 1. Exterior luminaires with lamps and ballasts.
- B. Section Does Not Include:
  - 1. Luminaire-mounted photoelectric relays.
  - 2. Poles and accessories.

1.3 DEFINITIONS

- A. Architect: The project Landscape Architect, Lighting Designer or Owner's Representative individually or collectively.
- B. BF: Ballast factor.
- C. CCT: Correlated color temperature.
- D. CRI: Color Rendering Index.
- E. FC: Footcandles.
- F. LED: Light Emitting Diode
- G. Lumen: Measured output of lamp or luminaire, or both.
- H. Luminaire: Complete lighting fixture, including housing, internal wiring, lamp(s), lens(es), shielding and/or ballast if provided.

1.4 GENERAL REQUIREMENTS

- A. Luminaires will be Furnished by owner and installed by Electrical contractor. Contractor shall be responsible to review all counts with owner prior to purchase. They shall also be responsible

to receive, and review luminaires for damage upon receipt of the product and protect luminaires during duration of construction. Luminaires shall not be utilized as temporary lighting fixtures and the contractor will be responsible for replacing any and all lamps used during construction.

- B. Provide all luminaires as shown, complete with all lamps, completely wired, controlled, and securely attached to supports.
- C. Where a catalog number and a narrative or pictorial description is provided, the written description shall take precedence and prevail.
- D. Contractor shall provide each specified manufacturer with complete information about the luminaires they will supply.
- E. Type of luminaires shall be as indicated alphanumerically and as specified.
- F. Luminaire details shown may be modified by the manufacturer provided all of the following conditions have been met:
  - 1. Luminaire performance is equal or improved.
  - 2. Structural, mechanical, electrical, safety, and maintenance characteristics are equal or improved.
  - 3. Cost to the Owner is reduced or equal.
  - 4. Modifications have been reviewed by the Owner and Consultant and been approved in writing.

#### 1.5 REFERENCES AND STANDARDS

- A. Recognized Standards: Luminaires shall comply with the applicable standards of the below organizations.
  - 1. UL Underwriters Laboratories
  - 2. NEC National Electric Code
  - 3. ANSI American National Standards Institute
  - 4. ASTM American Society of Testing and Materials
  - 5. NEMA National Electrical Manufacturers Association
  - 6. CBM Certified Ballast Manufacturers
- B. Regulatory Agencies
  - 1. Provide luminaires constructed, wired and installed in compliance with the current edition of applicable city, state and national codes. Provide luminaires conforming to or exceeding Underwriters Laboratories (UL) standards, and to provisions of applicable codes which exceed those standards.
  - 2. For any category of luminaire tested by any of the following agencies, provide luminaires listed and labeled by an independent Nationally Recognized Testing Laboratory (NRTL) such as UL, ETL, CSA, MET.

1.6 QUALITY ASSURANCE

- A. Luminaires and assembled components shall be new, of good quality, and be approved by and bear the label of UL or other approved testing agencies, i.e. CSA, ETL, unless otherwise specified in writing.
- B. All luminaires shall meet all required state and national building, electrical and energy codes and regulations.
- C. Luminaires of same type and style shall be from a single manufacturer.
- D. Lamps of each lamp type shall be from a single manufacturer and batch.
- E. Components and fixtures shall be listed and approved for use by Nationally Recognized Testing Laboratory (NRTL) including: UL, ETL, and CSA, or equivalent.
- F. Submitted products shall meet all aspects of this performance specification, or clearly indicate any variations, with a description of how the proposed product meets or exceeds the required performance.
- G. Luminaire Photometric Data Testing Laboratory Qualifications: Shall be provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 BIDDING

- A. Follow bidding procedures as described in General Conditions Section of this specification.

1.8 SUBSTITUTIONS

- A. Bidders' attention is called to the following procedure to be followed in submitting alternate luminaire manufacturers than those specified:
  - 1. Bidders wishing to obtain approval on brands other than those specified by name and catalog number in 2.2 LUMINAIRE DESCRIPTIONS section of this specification, shall submit their requests no later than ten (10) business days after the bid opening. Approval will be in the form of an addendum to the specifications issued to all prospective bidders indicating that the additional brand or brands are approved as equal to those specified as far as the requirements of the project are concerned. If the bidders do not elect to obtain prior approval during the time so specified, the Owner has no obligation to review or consider any such article after the contract award.
  - 2. If the bidder wishes to substitute luminaires from alternate manufacturers, the bidder's attention is called to Section 2.1, GENERAL MATERIAL REQUIREMENTS of PART 2 PRODUCTS. In addition, bidders shall note that the dimensions of visible parts of

- many luminaires (for example, the aperture diameters of recessed luminaires) are binding to the bidder and cannot be changed without prior approval by the Owner.
3. Contractor shall pay professional fees (at current standard hourly rates) and reimburse expenses directly to the Consultant for time spent reviewing substitutions proposed by the Contractor. If payment by the Contractor is not made within 60 days of invoice date, the Owner shall deduct the amount due from subsequent payments to the Contractor in order to reimburse designers.
  4. Request for approval shall be accompanied by working luminaire samples (with an appropriate lamp, complete photometric, mechanical and electrical data, list of materials and finishes and unit cost to the Owner) of both the specified brand and the proposed substitutes, as required, to make complete comparison and evaluation. These samples shall be in addition to those required by Luminaire Specification. The above data shall be delivered separately to the Consultant. The luminaire samples shall be furnished and installed, at the bidder's expense, at a location selected by the Architect. In addition, the bidder shall furnish the Consultant with the name and location of at least one completed project where each proposed substitute has been in operation for a period of at least six (6) months, as well as the names and addresses of the Owner.

#### 1.9 SUBMITTALS

- A. For standard catalog items with no modifications, submit manufacturer-prepared shop drawing submittals which clearly show all elements to be supplied and all corresponding product data (including lamping; ballast manufacturer and model number; voltage; accessories or options and any miscellaneous items detailed in the written description of the specification.) If submittal shows more than one (1) luminaire type or accessory options, all non-applicable information shall be crossed out.
- B. For custom luminaires, modified luminaires or linear fluorescent luminaires mounted in continuous rows, submit a computer-generated drawing prepared by the manufacturer showing all details of construction, housing and aperture lengths of runs, lamping layout, pendant locations, power locations, finishes and list of materials. Drawings must be to scale. Contractor shall provide manufacturer with field dimensions where required.
- C. For custom luminaires, manufacturer shall perform and submit all engineering calculations as required to ensure the safe and proper installation and operation of the luminaire.
- D. For all luminaires, submittal must include lamp and ballast to be provided with the luminaire. Statement of verification of compatibility with lighting controls required on each submittal by Contractor.
- E. For all submittals under paragraphs A through C above, manufacturer shall submit within 2 weeks of receipt of order. All submittals shall have project name and luminaire type clearly shown.
- F. Luminaire shop drawings shall be submitted in quantities and format as described in the general conditions section the specification.

- G. The Consultant shall make the final determination as to whether or not the submittal contains sufficient information and reserves the right to request supplemental information.
- H. For each type of lighting fixture purchased for the building and associated grounds within the project boundary, include lamps for both indoor and outdoor fixtures, lamps purchased in non-residential tenant spaces, as well as both hard-wired and portable fixtures, provide the following data:
  - 1. Luminaire cutsheets or other documentation indicating mean lumen output (design or actual).

#### 1.10 EXTRA STOCK

- A. Furnish to the Owner, and store at the site where directed, extra stock of 5% of the total for each Luminaire Type with all applicable trims, fasteners, brackets and other items packaged in manufacturer's unopened cartons and identified as to contents by luminaire type.
- B. Furnish to the Owner extra louver / lenses, ballasts and transformers in the following quantity: 5% of total for each type, but not fewer than 3 of each type.
- C. Furnish to the Owner spare lamps in the following quantity: 5% of total for each type, but not fewer than 5 of each type.
- D. Furnish to the Owner at least (1) spare driver and LED luminaire of each type.

#### 1.11 WARRANTIES

- A. All luminaires and workmanship shall be guaranteed free of defects and fully operational for a minimum of two years after the acceptance of the project by the Owner. Any luminaires or workmanship found to be defective during the warranty period will be either fixed or replaced by the Contractor at no cost to the Owner.
- B. LED luminaires, inclusive of LED chips, drivers, and power supplies, shall be guaranteed free of defects and fully operational for a minimum of three years after the acceptance of the project by the Owner. Any luminaires or workmanship found to be defective during the warranty period will be either fixed or replaced by the Contractor at no cost to the Owner.
- C. Ballasts for fluorescent and high intensity discharge luminaires shall be covered by a two-year warranty against defects in workmanship or material. Warranty shall include in warranty service program providing for payment of authorized labor charges incurred in replacement of inoperative, in warranty ballasts.

### PART 2 - PRODUCTS

- A. LUMINAIRE DESCRIPTIONS
  - 1. SEE PART 4 – LUMINAIRE SCHEDULE at the end of this Section.

## 2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
  - 1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
  - 2. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Light Shields: Metal baffles, factory installed and field adjustable, arranged to block light distribution to indicated portion of normally illuminated area or field.
- J. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
  - 1. White Surfaces: 85 percent.
  - 2. Specular Surfaces: 83 percent.
  - 3. Diffusing Specular Surfaces: 75 percent.
- K. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- L. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials. For weatherproof and vaportight installation, painted finishes of fixtures and accessories shall be weatherproof enamel using proper primers or hot dipped galvanized and bonderized epoxy, in accordance with manufacturer's requirements. Unless otherwise specified all painted surfaces shall have a life expectancy of not less than twenty years.
  - 1. Hangers shall be conduit with chemically resistant, weatherproof, baked enamel finish.



2. Where aluminum parts come in contact with bronze parts, apply to both surfaces a coating material to prevent corrosion.
  3. Colors shall be as specified in the LUMINAIRE DESCRIPTION section of this specification.
- M. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
  2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
    - a. Color: As selected from manufacturer's standard catalog of colors.
    - b. Color: Match Architect's sample of custom color.
    - c. Color: As selected by Architect from manufacturer's full range.
- N. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
  2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
  3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
  4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
    - a. Color: As shown on schedule
- O. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
    - a. "USES ONLY" and include specific lamp type.
    - b. Lamp tube configuration (twin, quad, triple), base type, and nominal wattage for compact fluorescent luminaires.
    - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
    - d. Start type (preheat, rapid start, instant start) compact fluorescent luminaires.
    - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
    - f. CCT and CRI for all luminaires.

2.3 LED LAMPS/LUMINAIRES

- A. Provide LED luminaires as specified in Section 2.1 LUMINAIRE DESCRIPTIONS, no equals.
- B. Drivers to be provided by LED luminaire manufacturer and verified to be compatible for successful operation of the specified system. Drivers to be UL listed independently of the LED luminaire.
- C. LED binning information for specific luminaires to be fabricated for the project to be provided with shop drawings for specifier approval.
- D. All components to be UL listed as a system unless otherwise submitted for approval.
- E. Submittals: Manufacturer to provide shop drawings including wiring diagram, driver limitations and installation requirements, and mounting details for this application for approval. Incomplete shop drawings will not be evaluated and resubmission will be required with no delay in the order process.
- F. Manufacturer to provide a warranty of at least five years on all parts including but not limited to LED chips and drivers.
- G. Prior to order and installation, provide Architect two working samples with 120V cord-and-plug of each LED luminaire type as specified for comparison.
- H. All luminaires and their contained LED chips and componentry shall be tested in accordance with applicable IESNA LM-79 and LM-80 methods.
- I. Operating temperature rating shall be between -40° F [-40° C] and 120° F [50° C].
- J. Correlated Color Temperature (CCT): As shown on luminaire schedule.
- K. Color Rendering Index (CRI): 70.
- L. The manufacturer shall have performed JEDEC (Joint Electron Devices Engineering Council) reliability tests on the LEDs as follows: High Temperature Operating Life (HTOL), Room Temperature Operating Life (RTOL), Low Temperature Operating Life (LTOL), Powered Temperature Cycle (PTMCL), Non-Operating Thermal Shock (TMSK), Mechanical Shock Variable Vibration Frequency, and Solder Heat Resistance (SHR).
- M. All LEDs shall be batch sorted for color and brightness consistency and shall be manufactured by the same LED manufacturer:
  - 1. Cree
  - 2. Nichia
  - 3. Lumileds/Philips
  - 4. Osram/Sylvania
  - 5. Xicato
  - 6. Others as approved by lighting designer

- N. Substitution of LEDs by other manufacturers shall be equal in all respects of initial and maintained lumen output, lamp life, color consistency and compatibility with specified equipment. LED's shall be warm white color temperature consistent to 3500 Kelvin, except as noted otherwise in the luminaire schedule. Substitutions shall be submitted in the form of both manufacturer's printed data and corresponding samples for review
- O. LED lumen output shall be tested in accordance with applicable IESNA LM-79 and LM-80 methods with no more than 30% depreciation in lumen output after 50,000 hours of operation.
- P. Luminaire manufacturers wishing to supply LEDs in their products other than those listed above must verify that the LED manufacturer has been fabricating LEDs for a minimum of five years.

### PART 3 - EXECUTION

#### 3.1 SHIPPING AND STORAGE

- A. All luminaires received at the site shall be stored in clean and dry space until luminaires are installed.
- B. Manufacturer shall clearly mark each box with luminaire designation prior to shipping.
- C. Accessories, including lenses, snoots, baffles, louvers, aperture plates, and decorative elements of luminaires, shall be packed by the manufacturer separate from the housing (body, stem, etc.) of the luminaire.

#### 3.2 LOCATION

- A. Locations of luminaires are shown diagrammatically. Verify exact location and spacing with Lighting Plans, field conditions, and/or other reference data before ordering of luminaires and during installation.
- B. Install new luminaires in the same location in the same orientation and mounting configuration as existing luminaire unless otherwise specified.
- C. Notify Owner about field conditions at variance with Implementation Documents before commencing installation.

#### 3.3 LUMINAIRE INSTALLATION

- A. Install lamps in each luminaire.
- B. Fasten luminaire to indicated structural supports.
  - 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

- C. Provide labor and materials for final aiming of all adjustable luminaires under the Consultant's supervision. Aiming shall take place immediately before project is turned over to Owner, after sunset, where required. Contractor shall have all tools, ladders, and equipment for accessing each luminaire as well as complete stock of lenses, spare lamps, and ballasts, as required by this specification.
- D. Mask luminaires if necessary to protect the luminaire during construction. At the completion of construction, clean the bottoms, the trim, the reflecting surfaces, lenses, baffles, louvers, and snoots of all luminaires so as to render them free of any material, substance, or film foreign to the luminaire. If the luminaires are deemed dirty by the Owner at the completion of the project, the Contractor shall clean them at no additional cost to the Owner. Luminaire components whose finishes are damaged shall be replaced at no cost to the Owner.
- E. Ascertain and ensure that all lamps installed are exactly as specified for each luminaire type.

### 3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

### 3.5 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole unless otherwise indicated.
  - 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
  - 1. Install grounding electrode for each pole unless otherwise indicated.
  - 2. Install grounding conductor and conductor protector.
  - 3. Ground metallic components of pole accessories and foundations.

PART 4 - LUMINAIRE SCHEDULE

Type	Mounting	Description	Lamping	Manufacturer & Model	Remarks
AX01 Exterior Accent	Ceiling, Surface	Nominal Aperture: 2.15" Round Nominal Size: 2 1/4"D x 6 1/2"H Optics: 31° beam, Soft Focus Lens Trim Style: Canopy at J-box Reflector: N/A Finish: TBD Housing: Machined Aluminum Driver: Remote - Dimming, 0- 10V	Wattage: 7 Lumens Delivered: 459 Type: LED Module Color Temp: 4000K Min CRI: 80	Mfr: BK Lighting Series: Delta Star Model: DS LED e66 WF A9 TBD 12 11 B  Alt Mfr: Vision3, Lumiere	To be mounted such that bottom of luminaire is at same height as adjacent angled beam. To be aimed directly downward. Remote drivers to be located by EE in accessi- ble location. Emergency where re- quired.
AX02 Exterior Wallpack	Wall, Recessed	Nominal Aperture: 15"W x 8 3/16"D Nominal Size: 17"W x 10 3/16"L x 8 1/2"H Optics: Clear Lens Trim Style: Overlap Flange Reflector: Semi-Specular Finish: TBD Housing: Die-cast Aluminum Driver: Dimming, 0-10V	Wattage: 12 Lumens Delivered: 1513 Type: LED Module Color Temp: 4000K Min CRI: 70	Mfr: Lithonia Series: WST LED Model: WSTLED P1 40 VF MVOLT DS  Alt Mfr: Gardco, Signtex	Specified with dual switching to meet CT State egress door re- quirements. Emergency where re- quired.
AX03 Exterior Linear Pendant	Ceiling, Suspended	Nominal Aperture: 4" Linear Nominal Size: 4 1/2"W x 48"L x 3 3/4"H Optics: Asymmetric Throw Suspension Style: Rigid Stem Reflector: White Finish: TBD Housing: Extruded Aluminium Driver: Dimming, 0-10V, 1%	Wattage: 19.5 Lumens Delivered: 2000 Type: LED Board Color Temp: 4000K Min CRI: 80	Mfr: Lumenwerx Series: Via Wet LED Model: VIAWETASYP TMG HLO LED 80 500 40 4' UNV D1 1 TD 55WSW18 TBD  Alt Mfr: Axis, Alight	Emergency where re- quired.
AX04 Area Light	Pole	Nominal Aperture: 13"W x 10"L Nominal Size: 15 3/4"W x 12 1/8"L x 5"H Optics: AccuLED Optics Trim Style: N/A Reflector: Semi-specular Finish: TBD Housing: Die-cast Aluminum Driver: Dimming, 0-10V, 10%	Wattage: 59 Lumens Delivered: 6179 Type: LED Board Color Temp: 4000K Min CRI: 80	Mfr: Eaton Series: GAP Galleon Model: GAP AF 01 LED U SL4 TBD QM 8040 TBD  Alt Mfr: Ligman, Eaton	Luminaire must be full cutoff, with an uplight rating of U1 or lower. To be provided with compatible pole and necessary mounting accessories. Approxi- mate head height to be 16'-0" AFF. Emergency where re- quired.
AX04a Area Light	Pole	Same as AX04, except 20'-0" AFF mounting.			
AX05 Bollard	Pole	Nominal Aperture: 8"W x 5"H Nominal Size: 8"D x 48"H Optics: Acrylic Trim Style: N/A Reflector: Matte Black Finish: TBD Housing: Die-cast Aluminium Driver: Integral	Wattage: 14.1 Lumens Delivered: 1083 Type: LED Module Color Temp: 4000K Min CRI: 80	Mfr: Selux Series: Inula Bollard LED Model: IBL 4 2Q90 40 TBD TBD  Alt Mfr: .hess, Eaton	Luminaire must be full cutoff, with an uplight rating of U1 or lower. Emergency where re- quired.

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AX06 Steplight	Surface J-Box	Nominal Aperture: 10.2"W x 4"H x 3"D Optics: Concealed Finish: TBD Housing: Die-cast Aluminium Driver: Integral	Wattage: 11 Lumens Delivered: 783 Type: LED Module Color Temp: 4000K Min CRI: 80	Mfr: Ligman Series: Abacus Model: UAB-30001-11w- W40-tbd-120/277v-SCE  Alt Mfrs: Bega, Eaton, Hubbell, Acuity, Signify	Contractor to provide mock-up of installation for architect review prior to ordering. Surface Conduit Decora- tive Trim accessory is required for installation. Luminaire must be full cutoff, with an uplight rating of U1 or lower.
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END OF SECTION 265100

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SECTION 270526 - GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Wire.
  - 2. Mechanical connectors.
  - 3. Exothermic connections.
- B. Related Sections:
  - 1. Section 26 0526 - Grounding and Bonding for Electrical Systems.
  - 2. See Division 01 – General Requirements.

1.2 REFERENCES

- A. Building Industry Consulting Service International, Inc.
  - 1. BICSI TDM Manual - Telecommunications Distribution Methods Manual.
- B. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.
- C. Telecommunication Industry Association/Electronic Industries Alliance:
  - 1. TIA/EIA 607 - Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.3 SYSTEM DESCRIPTION

- A. Communications grounding systems use the following elements as grounding electrodes:
  - 1. Building grounding electrode.
- B. Do not use the following elements as grounding electrodes:
  - 1. Building plumbing system.

1.4 PERFORMANCE REQUIREMENTS

- A. Grounding System Resistance: 5 ohms maximum.

1.5 SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Product Data: Submit data on grounding electrodes and connections.
- C. Test Reports: Indicate overall resistance to ground and resistance of each electrode.
- D. Manufacturer's Installation Instructions: Submit for active electrodes.

- E. Manufacturer's Certificate: Certify meet or exceed specified requirements.

#### 1.6 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Project Record Documents: Record actual locations of components and grounding electrodes.

#### 1.7 QUALITY ASSURANCE

- A. Provide grounding, surge protection and lightning protection of telecommunications system in accordance with latest version of Grounding, Bonding and Electrical Protection chapter of the BICSI TDM Manual, TIA/EIA 607, and NFPA 70.
- B. Maintain one copy of each document on site.

#### 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum three years experience approved by manufacturer.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General Requirements.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

#### 1.10 COORDINATION

- A. See Division 01 – General Requirements.
- B. Complete grounding and bonding of building reinforcing steel prior concrete placement.

### PART 2 PRODUCTS

#### 2.1 WIRE

- A. Material: Stranded copper.
- B. Grounding Conductor: Copper conductor bare.



- C. Bonding Conductor: Copper conductor bare.

## 2.2 MECHANICAL CONNECTORS

- A. Manufacturers:
  1. Copperweld, Inc.
  2. Erico, Inc.
  3. O-Z Gedney Co.
  4. Thomas & Betts, Electrical
  5. Substitutions: See Division 01 - General Requirements.
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.

## 2.3 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
  1. Cadweld, Erico, Inc.
  2. Copperweld, Inc.
  3. ILSCO Corporation.
  4. O-Z Gedney Co.
  5. Thomas & Betts, Electrical.
  6. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

## PART 3 EXECUTION

### 3.1 PREPARATION

- A. Remove paint, rust, mill oils, surface contaminants at connection points.

### 3.2 INSTALLATION

- A. Install in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.
- B. Provide grounding/bonding for each communication rack using #4 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor. Terminate to copper communication grounding Bar in each telecommunications room.
- C. Bond main telecommunications grounding system to building grounding electrode system at main electrical service entrance location with #3/0 AWG THHN, rated for 90 degrees C, insulated, copper stranded conductor.
- D. Routing of grounding conductor shall be as short and direct as practical.

- E. Install routing of bonding conductors with minimum number of bends and splices. Use sweeping bends.
- F. Install bonding connections with listed bolts, crimp pressure connectors, clamps, or lugs.
- G. Within each MDF/IDF room, provide ground bar mounted to isolating stand offs, with pre-drilled holes for accepting cable spade lugs. Each ground bus shall connect to the next with #3/0 AWG insulated green wire, and the final termination shall be at the main demarc location.
- H. Position busbars near associated equipment and insulate from supports.
- I. Construct busbars of copper, 4 inches x 8 inches by 1/4 inch thick with pilot holes for ground lug.
- J. Bond backbone cabling at each sheath opening.
- K. Ground/bond data cabinets, racks, cable trays.
- L. Conduit stub/sleeves shall be installed with ground bushings and form a continuous bonded surface.
- M. Install ground from each piece of equipment to grounding bar via an insulated cable no smaller than 6 AWG stranded copper wire. Install proper grounding lug on cable where connecting to racks and grounding bar.
- N. Label grounding conductors and grounding bus bars in accordance with BICSI guidelines.
- O. Permanently attach equipment and grounding conductors prior to energizing equipment.

### 3.3 FIELD QUALITY CONTROL

- A. See Division 01 – General Requirements.
- B. Visually inspect from each bus bar to main grounding electrode service location.
- C. Test in accordance with BICSI TDM Manual, TIA/EIA 607, and NFPA 70.
- D. When improper grounding is found, check entire project and correct. Perform retest.

END OF SECTION 270526

SECTION 270529 - HANGERS AND SUPPORTS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Conduit supports.
  - 2. Formed steel channel.
  - 3. Spring steel clips.
  - 4. Sleeves.
  - 5. Mechanical sleeve seals.
  - 6. Equipment bases and supports.
  
- B. Related Sections:
  - 1. Section 03 30 00 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
  - 2. Division 07 Section – Penetration Firestopping.
  - 3. Section 26 05 29 - Hangers and Supports for Electrical Systems.
  - 4. Section 27 15 00 – Communications Horizontal Cabling.

1.2 REFERENCES

- A. ASTM International:
  - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
  - 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
  - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
  
- B. FM Global:
  - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
  
- C. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.
  
- D. Underwriters Laboratories Inc.:
  - 1. UL 263 - Fire Tests of Building Construction and Materials.
  - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
  - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.
  - 4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
  - 5. UL - Fire Resistance Directory.

1.3 SUBMITTALS

- A. Section 01 33 00 - Submittal Procedures: Requirements for submittals.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data:
  - 1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
- D. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- E. Manufacturer's Installation Instructions:
  - 1. Hangers and Supports: Submit special procedures and assembly of components.
- F. Manufacturer's Certificate: Certify products meet or exceed specified requirements.

1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum three years experience, approved by manufacturer.

1.5 PRE-INSTALLATION MEETINGS

- A. Section 01 30 00 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01 60 00 - Product Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

## PART 2 PRODUCTS

### 2.1 CONDUIT SUPPORTS

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. Electroline Manufacturing Company.
  - 3. O-Z Gedney Co.
  - 4. Thomas and Betts
  - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self locking.

### 2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. B-Line Systems.
  - 3. Midland Ross Corporation, Electrical Products Division.
  - 4. Unistrut Corp.
  - 5. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

### 2.3 SPRING STEEL CLIPS

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. B-Line Systems
  - 3. Midland Ross Corporation, Electrical Products Division.
  - 4. Unistrut Corp.
  - 5. Substitutions: Section 01 60 00 - Product Requirements
- B. Product Description: Mounting hole and screw closure.

## 2.4 SLEEVES

- A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Fire-stopping Insulation: Glass fiber type, non-combustible.

## 2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
  - 1. Thunderline Link-Seal, Inc.
  - 2. NMP Corporation.
  - 3. PSI Link-Seal.
  - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01 30 00 - Administrative Requirements: Verification of existing conditions before starting work.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.

### 3.2 PREPARATION

- A. Clean substrate surfaces of dirt, dust, grease, oil, loose material, or other matter affecting bond of firestopping material.
- B. Remove incompatible materials affecting bond.
- C. Obtain permission from Architect/Engineer before using powder-actuated anchors.
- D. Do not drill or cut structural members.

### 3.3 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
  - 1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
  - 2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
  - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
  - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
  - 5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
  - 6. Sheet Metal: Provide sheet metal screws.
  - 7. Wood Elements: Provide wood screws.
  
- B. Inserts:
  - 1. Install inserts for placement in concrete forms.
  - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
  - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
  
- C. Install conduit and raceway support and spacing in accordance with NEC.
  
- D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
  
- E. Install multiple conduit runs on common hangers.
  
- F. Supports:
  - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
  - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
  - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
  - 4. Support vertical conduit at every floor.

### 3.4 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. Refer to Section 03 30 00.
  
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
  
- C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.5 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

3.6 FIELD QUALITY CONTROL

- A. Section 01 70 00 - Execution and Closeout Requirements: Field inspecting, testing, adjusting, and balancing.

3.7 CLEANING

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for cleaning.

3.8 PROTECTION OF FINISHED WORK

- A. Section 01 70 00 - Execution and Closeout Requirements: Requirements for protecting finished Work.
- B. Protect adjacent surfaces from damage by material installation.

END OF SECTION 270529



SECTION 270533 - CONDUITS AND BACKBOXES FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
  - 1. See Division 07 – Penetration Firestopping.
  - 2. Section 26 0503 - Equipment Wiring Connections.
  - 3. Section 26 0533 - Raceway and Boxes for Electrical Systems.
  - 4. Section 26 0534 - Floor Boxes for Electrical Systems.
  - 5. Section 27 0526 - Grounding and Bonding for Communications Systems.
  - 6. Section 27 0529 - Hangers and Supports for Communications Systems.
  - 7. Section 27 0553 - Identification for Communications Systems.

1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
  - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
- B. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
  - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
  - 4. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
  - 5. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground More than 5 feet outside Foundation Wall: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.
- C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.
- D. In or Under Slab on Grade: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide rigid steel conduit sweeps.

- E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.
  - F. Wet and Damp Locations: Provide rigid steel conduit, electrical metallic tubing. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
  - G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
  - H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- 1.4 DESIGN REQUIREMENTS
- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.
- 1.5 SUBMITTALS
- A. See Division 01 – General Requirements.
  - B. Product Data: Submit for the following:
    - 1. Liquidtight flexible metal conduit.
    - 2. Nonmetallic conduit.
    - 3. Nonmetallic tubing.
    - 4. Raceway fittings.
    - 5. Conduit bodies.
    - 6. Surface raceway.
    - 7. Wireway.
    - 8. Pull and junction boxes.
    - 9. Handholes.
  - C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- 1.6 CLOSEOUT SUBMITTALS
- A. See Division 01 – General Requirements.
  - B. Project Record Documents:
    - 1. Record actual routing of conduits larger than 2 inch.
    - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General Requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.8 COORDINATION

- A. See Division 01 – General Requirements.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 0503.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
  - 1. Allied Tube and Conduit.
  - 2. Western Tube and Conduit.
  - 3. Wheatland Tube Company.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
  - 1. Carlon Electrical Products.
  - 2. Anamet Electrical.
  - 3. Allied Tube and Conduit.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Interlocked steel construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
  - 1. Allied Tube and Conduit.
  - 2. Western Tube and Conduit.
  - 3. Wheatland Tube Company.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression (damp locations), and set screw type.

2.4 SURFACE METAL RACEWAY

- A. Manufacturers:
  - 1. Hubbell Wiring Devices.
  - 2. Thomas & Betts Corp.
  - 3. The Wiremold Co.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- C. Size: as indicated on drawings.
- D. Finish: Manufacturers standard finish as selected by Architect.
- E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.5 OUTLET BOXES

- A. Manufacturers:
  - 1. Erico Products.
  - 2. Raco.
  - 3. Thomas & Betts Corp.
  - 4. Substitutions: See Division 01 – General Requirements.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
  - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
  - 2. Concrete Ceiling Boxes: Concrete type.
- C. Cast Boxes: NEMA FB 1, Type FD, cast ferroalloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 2726.

- E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

## 2.6 PULL AND JUNCTION BOXES

- A. Manufacturers:
  - 1. Carlon Electrical Products.
  - 2. Hubbell Wiring Devices.
  - 3. Thomas & Betts Corp.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Hinged Enclosures: As specified in Section 26 2716.
- D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
  - 1. Material: Galvanized cast iron.
  - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- E. Concrete Composite Handholes: Die-molded, concrete composite hand holes:
  - 1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
  - 2. Cover: Concrete composite, weatherproof cover with nonskid finish.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. See Division 01 – General Requirements.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

### 3.2 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 0526.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 27 0529.
- C. Identify raceway and boxes in accordance with Section 27 0553.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 26 0529; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 0529.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit under slab from point-to-point.
- K. Maintain clearance between raceway and piping for maintenance purposes.
- L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- M. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- N. Bring conduit to shoulder of fittings; fasten securely.
- O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.
- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.

- S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- W. Close ends and unused openings in wireway.

#### 3.4 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in section for outlet device.
- B. Coordinate communications device locations with furniture plan and receptacle locations to accommodate the intended purpose prior to rough-in.
- C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.

- N. Install gang box where more than one device is mounted together. Do not use sectional box.
- O. Install gang box with plaster ring for single device outlets.

### 3.5 INTERFACE WITH OTHER PRODUCTS

- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07 Section “Penetration Firestopping”.
- B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.
- C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
- D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.

### 3.6 ADJUSTING

- A. See Division 01 – General Requirements.
- B. Adjust flush-mounting outlets to make front flush with finished wall material.
- C. Install knockout closures in unused openings in boxes.

### 3.7 CLEANING

- A. See Division 01 – General Requirements.
- B. Clean interior of boxes to remove dust, debris, and other material.
- C. Clean exposed surfaces and restore finish.

END OF SECTION 270533



SECTION 270553 - IDENTIFICATION FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Nameplates.
  - 2. Labels.
  - 3. Wire markers.
  - 4. Conduit markers.
  
- B. Related Sections:
  - 1. See Division 09 - Painting: Execution requirements for painting specified by this section.
  - 2. Section 26 0553 - Identification for Electrical Systems.

1.2 SUBMITTALS

- A. See Division 01 – General Requirements.
  
- B. Product Data:
  - 1. Submit manufacturer’s catalog literature for each product required.
  - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
  
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General Requirements.
  
- B. Accept identification products on site in original containers. Inspect for damage.
  
- C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
  
- D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.5 ENVIRONMENTAL REQUIREMENTS

- A. See Division 01 – General Requirements.
- B. Install labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

PART 2 PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
  - 1. Seton.
  - 2. Brady.
  - 3. Ideal Industries
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
- C. Letter Size:
  - 1. 1/8 inch high letters for identifying individual equipment and loads.
  - 2. 1/4 inch high letters for identifying grouped equipment and loads.
- D. Minimum nameplate thickness: 1/8 inch.

2.2 LABELS

- A. Manufacturers:
  - 1. Seton.
  - 2. Brady.
  - 3. Ideal Industries
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Labels: Embossed, pre-printed adhesive tape, with 3/16 inch white letters on black background.

2.3 CONDUIT AND RACEWAY MARKERS

- A. Manufacturers:
  - 1. Seton.
  - 2. Brady.
  - 3. Ideal Industries
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Description: Nameplate fastened with straps.

- C. Color:
  - 1. Voice System: Blue lettering on white background.
  - 2. Data System: White lettering on black background.
  
- D. Legend:
  - 1. Voice system: VOICE.
  - 2. Data System: TELECOMMUNICATIONS.
  - 3. Audiovisual Systems: AV

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
  
- B. Prepare surfaces in accordance with Division 09 for stencil painting.

#### 3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
  
- B. Nameplate Installation:
  - 1. Install nameplate parallel to equipment lines.
  - 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
  - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
  - 4. Secure nameplate to equipment front using screws.
  - 5. Install nameplates for the following:
    - a. Equipment racks and cabinets.
  
- C. Label Installation:
  - 1. Labeling procedures shall meet TIA/EIA 568B Series standard and BICSI Standards and shall be pre-approved by the Architect.
  - 2. Permanently label, using pre-printed labels, all cables and terminations.
    - a. Patch panels and cross-connect blocks, numerically from top to bottom.
    - b. Patch panel port with work area outlet label.
    - c. Cable segments.
  - 3. Install label parallel to equipment lines.
  - 4. Use industry standard TIA/EIA and BICSI color codes.
  
- D. Conduit Marker Installation:
  - 1. Install conduit marker for each conduit longer than 10 feet.
  - 2. Conduit Marker Spacing: 20 feet on center.

END OF SECTION 270553

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SECTION 280529 - HANGERS AND SUPPORTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Conduit supports.
  - 2. Formed steel channel.
  - 3. Spring steel clips.
  - 4. Sleeves.
  - 5. Mechanical sleeve seals.
  - 6. Firestopping relating to electrical work.
  - 7. Firestopping accessories.
  - 8. Equipment bases and supports.
  
- B. Related Sections:
  - 1. See Division 03 - Cast-In-Place Concrete: Product requirements for concrete for placement by this section.
  - 2. See Division 07 – Penetration Firestopping.
  - 3. Section 26 0529 - Hangers and Supports for Electrical Systems.
  - 4. Section 27 0529 - Hangers and Supports for Communications Systems.

1.2 REFERENCES

- A. ASTM International:
  - 1. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
  - 2. ASTM E119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
  - 3. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
  - 4. ASTM E1966 - Standard Test Method for Fire-Resistive Joint Systems.
  
- B. FM Global:
  - 1. FM - Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
  
- C. National Fire Protection Association:
  - 1. NFPA 70 - National Electrical Code.
  
- D. Underwriters Laboratories Inc.:
  - 1. UL 263 - Fire Tests of Building Construction and Materials.
  - 2. UL 723 - Tests for Surface Burning Characteristics of Building Materials.
  - 3. UL 1479 - Fire Tests of Through-Penetration Firestops.

4. UL 2079 - Tests for Fire Resistance of Building Joint Systems.
5. UL - Fire Resistance Directory.

### 1.3 SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- C. Product Data:
  1. Hangers and Supports: Submit manufacturers catalog data including load capacity.
  2. Firestopping: Submit data on product characteristics, performance and limitation criteria.
- D. Firestopping Schedule: Submit schedule of opening locations and sizes, penetrating items, and required listed design numbers to seal openings to maintain fire resistance rating of adjacent assembly.
- E. Design Data: Indicate load carrying capacity of trapeze hangers and hangers and supports.
- F. Manufacturer's Installation Instructions:
  1. Hangers and Supports: Submit special procedures and assembly of components.
  2. Firestopping: Submit preparation and installation instructions.
- G. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
- H. Engineering Judgements: For conditions not covered by UL listed designs, submit judgements by licensed professional engineer suitable for presentation to authority having jurisdiction for acceptance as meeting code fire protection requirements.

### 1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years experience.
- B. Installer: Company specializing in performing work of this section with minimum years experience approved by manufacturer.

### 1.5 PRE-INSTALLATION MEETINGS

- A. Section 01 3000 - Administrative Requirements: Pre-installation meeting.
- B. Convene minimum one week prior to commencing work of this section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01- General Requirements.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification.
- C. Protect from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original packaging.

PART 2 PRODUCTS

2.1 CONDUIT SUPPORTS

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. Electroline Manufacturing Company.
  - 3. O-Z Gedney Co.
  - 4. Thomas and Betts
  - 5. Substitutions: See Division 01 - General Requirements.
- B. Hanger Rods: Threaded high tensile strength galvanized carbon steel with free running threads.
- C. Beam Clamps: Malleable Iron, with tapered hole in base and back to accept either bolt or hanger rod. Set screw: hardened steel.
- D. Conduit clamps for trapeze hangers: Galvanized steel, notched to fit trapeze with single bolt to tighten.
- E. Conduit clamps - general purpose: One-hole malleable iron for surface mounted conduits.
- F. Cable Ties: High strength nylon temperature rated to 185 degrees F. Self-locking.
  - 1. Cable ties shall be plenum rated.

2.2 FORMED STEEL CHANNEL

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. B-Line Systems.
  - 3. Midland Ross Corporation, Electrical Products Division.
  - 4. Unistrut Corp.
  - 5. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Galvanized 12 gage thick steel. With holes 1-1/2 inches on center.

### 2.3 SPRING STEEL CLIPS

- A. Manufacturers:
  - 1. Allied Tube & Conduit Corp.
  - 2. B-Line Systems
  - 3. Midland Ross Corporation, Electrical Products Division.
  - 4. Unistrut Corp.
  - 5. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Mounting hole and screw closure.

### 2.4 SLEEVES

- A. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Floors: 18 gage thick galvanized steel.
- B. Sleeves for conduit, cable tray, raceway or cable through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 gage thick galvanized steel.
- C. Sleeves for conduit, cable tray, raceway, or cable through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Fire-stopping Insulation: Glass fiber type, non-combustible.

### 2.5 MECHANICAL SLEEVE SEALS

- A. Manufacturers:
  - 1. Thunderline Link-Seal, Inc.
  - 2. NMP Corporation.
  - 3. PSI Link-Seal.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between object and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. See Division 01 - General Requirements.
- B. Verify openings are ready to receive sleeves.
- C. Verify openings are ready to receive firestopping.



### 3.2 INSTALLATION - HANGERS AND SUPPORTS

- A. Anchors and Fasteners:
  - 1. Concrete Structural Elements: Provide precast inserts and expansion anchors.
  - 2. Steel Structural Elements: Provide beam clamps, spring steel clips, and welded fasteners.
  - 3. Concrete Surfaces: Provide self-drilling anchors and expansion anchors.
  - 4. Hollow Masonry, Plaster, and Gypsum Board Partitions: Provide toggle bolts and hollow wall fasteners.
  - 5. Solid Masonry Walls: Provide expansion anchors and preset inserts.
  - 6. Sheet Metal: Provide sheet metal screws.
  - 7. Wood Elements: Provide wood screws.
  
- B. Inserts:
  - 1. Install inserts for placement in concrete forms.
  - 2. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
  - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
  - 4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
  - 5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut flush with top of slab.
  
- C. Install conduit and raceway support and spacing in accordance with NEC.
  
- D. Do not fasten supports to pipes, ducts, mechanical equipment, or conduit.
  
- E. Install multiple conduit runs on common hangers.
  
- F. Supports:
  - 1. Fabricate supports from structural steel or formed steel channel. Install hexagon head bolts to present neat appearance with adequate strength and rigidity. Install spring lock washers under nuts.
  - 2. Install surface mounted cabinets and panelboards with minimum of four anchors.
  - 3. In wet and damp locations install steel channel supports to stand cabinets and panelboards 1 inch off wall.
  - 4. Support vertical conduit at every floor.

### 3.3 INSTALLATION - EQUIPMENT BASES AND SUPPORTS

- A. Provide housekeeping pads of concrete, minimum 3-1/2 inches thick and extending 6 inches beyond supported equipment. See Division 03.
  
- B. Using templates furnished with equipment, install anchor bolts, and accessories for mounting and anchoring equipment.
  
- C. Construct supports of formed steel channel. Brace and fasten with flanges bolted to structure.

3.4 INSTALLATION - SLEEVES

- A. Exterior watertight entries: Seal with adjustable interlocking rubber links.
- B. Conduit penetrations not required to be watertight: Sleeve and fill with silicon foam.
- C. Set sleeves in position in forms. Provide reinforcing around sleeves.
- D. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- E. Extend sleeves through floors 1 inch above finished floor level. Caulk sleeves.
- F. Where conduit or raceway penetrates floor, ceiling, or wall, close off space between conduit or raceway and adjacent work with fire stopping insulation and caulk airtight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- G. Install chrome plated steel escutcheons at finished surfaces.

3.5 FIELD QUALITY CONTROL

- A. See Division 01 – General Requirements.

3.6 CLEANING

- A. See Division 01 – General Requirements.

3.7 PROTECTION OF FINISHED WORK

- A. See Division 01 – General Requirements.

END OF SECTION 280529

SECTION 280533 - CONDUITS AND BACKBOXES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

- A. Section includes conduit and tubing, surface raceways, wireways, outlet boxes, pull and junction boxes, and handholes.
- B. Related Sections:
  - 1. See Division 07 – Penetration Firestopping.
  - 2. Section 26 0503 - Equipment Wiring Connections.
  - 3. Section 26 0533 - Raceway and Boxes for Electrical Systems.
  - 4. Section 26 2726 - Wiring Devices.
  - 5. Section 27 0533 - Conduits and Backboxes for Communications Systems.
  - 6. Section 28 0529 - Hangers and Supports for Electronic Safety and Security.
  - 7. Section 28 0553 - Identification for Electronic Safety and Security.

1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
  - 2. ANSI C80.3 - Specification for Electrical Metallic Tubing, Zinc Coated.
- B. National Electrical Manufacturers Association:
  - 1. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
  - 2. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
  - 3. NEMA OS 1 - Sheet Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
  - 4. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
  - 5. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.

1.3 SYSTEM DESCRIPTION

- A. Raceway and boxes located as indicated on Drawings, and at other locations required for splices, taps, wire pulling, equipment connections, and compliance with regulatory requirements. Raceway and boxes are shown in approximate locations unless dimensioned. Provide raceway to complete wiring system.
- B. Underground More than 5 feet outside Foundation Wall: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide cast metal boxes or nonmetallic handhole.
- C. Underground within 5 feet from Foundation Wall: Provide rigid steel conduit. Provide cast metal or nonmetallic boxes.
- D. In or Under Slab on Grade: Provide thickwall Schedule 40/80 nonmetallic conduit. Provide rigid steel conduit sweeps.

- E. Outdoor Locations, Above Grade: Provide rigid steel conduit. Provide cast metal outlet, pull, and junction boxes.
  - F. Wet and Damp Locations: Provide rigid steel conduit, electrical metallic tubing. Provide cast metal outlet, junction, and pull boxes. Provide flush mounting outlet box in finished areas.
  - G. Concealed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
  - H. Exposed Dry Locations: Provide electrical metallic tubing. Provide sheet-metal boxes. Provide flush mounting outlet box in finished areas. Provide hinged enclosure for large pull boxes.
- 1.4 DESIGN REQUIREMENTS
- A. Minimum Raceway Size: 3/4 inch unless otherwise specified.
- 1.5 SUBMITTALS
- A. See Division 01 – General Requirements.
  - B. Product Data: Submit for the following:
    - 1. Liquidtight flexible metal conduit.
    - 2. Nonmetallic conduit.
    - 3. Nonmetallic tubing.
    - 4. Raceway fittings.
    - 5. Conduit bodies.
    - 6. Surface raceway.
    - 7. Wireway.
    - 8. Pull and junction boxes.
    - 9. Handholes.
  - C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.
- 1.6 CLOSEOUT SUBMITTALS
- A. See Division 01 – General Requirements.
  - B. Project Record Documents:
    - 1. Record actual routing of conduits larger than 2 inch.
    - 2. Record actual locations and mounting heights of outlet, pull, and junction boxes.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General Requirements.
- B. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- C. Protect PVC conduit from sunlight.

1.8 COORDINATION

- A. See Division 01 – General Requirements.
- B. Coordinate installation of outlet boxes for equipment connected under Section 26 0503.
- C. Coordinate mounting heights, orientation and locations of outlets mounted above counters, benches, and backsplashes.

PART 2 PRODUCTS

2.1 METAL CONDUIT

- A. Manufacturers:
  - 1. Allied Tube and Conduit.
  - 2. Western Tube and Conduit.
  - 3. Wheatland Tube Company.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Rigid Steel Conduit: ANSI C80.1.
- C. Fittings and Conduit Bodies: NEMA FB 1; all steel fittings.

2.2 LIQUIDTIGHT FLEXIBLE METAL CONDUIT

- A. Manufacturers:
  - 1. Carlon Electrical Products.
  - 2. Anamet Electrical.
  - 3. Allied Tube and Conduit.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Interlocked steel construction with PVC jacket.
- C. Fittings: NEMA FB 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

- A. Manufacturers:
  - 1. Allied Tube and Conduit.
  - 2. Western Tube and Conduit.
  - 3. Wheatland Tube Company.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: ANSI C80.3; galvanized tubing.
- C. Fittings and Conduit Bodies: NEMA FB 1; steel, compression (damp locations), and set screw type.

2.4 SURFACE METAL RACEWAY

- A. Manufacturers:
  - 1. Hubbell Wiring Devices.
  - 2. Thomas & Betts Corp.
  - 3. The Wiremold Co.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Sheet metal channel with fitted cover, suitable for use as surface metal raceway.
- C. Size: as indicated on drawings.
- D. Finish: Manufacturers standard finish as selected by Architect.
- E. Fittings, Boxes, and Extension Rings: Furnish manufacturer's standard accessories; match finish on raceway.

2.5 OUTLET BOXES

- A. Manufacturers:
  - 1. Erico Products.
  - 2. Raco.
  - 3. Thomas & Betts Corp.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Sheet Metal Outlet Boxes: NEMA OS 1, galvanized steel.
  - 1. Luminaire and Equipment Supporting Boxes: Rated for weight of equipment supported; furnish 1/2 inch male fixture studs where required.
  - 2. Concrete Ceiling Boxes: Concrete type.
- C. Cast Boxes: NEMA FB 1, Type FD, cast ferroalloy. Furnish gasketed cover by box manufacturer. Furnish threaded hubs.
- D. Wall Plates for Finished Areas: As specified in Section 26 2726.

- E. Wall Plates for Unfinished Areas: Furnish gasketed cover.

## 2.6 PULL AND JUNCTION BOXES

- A. Manufacturers:
  - 1. Carlon Electrical Products.
  - 2. Hubbell Wiring Devices.
  - 3. Thomas & Betts Corp.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Sheet Metal Boxes: NEMA OS 1, galvanized steel.
- C. Hinged Enclosures: As specified in Section 26 2716.
- D. Surface Mounted Cast Metal Box: NEMA 250, Type 4; flat-flanged, surface mounted junction box:
  - 1. Material: Galvanized cast iron.
  - 2. Cover: Furnish with ground flange, neoprene gasket, and stainless steel cover screws.
- E. Concrete Composite Handholes: Die-molded, concrete composite hand holes:
  - 1. Cable Entrance: Pre-cut 6 inch x 6 inch cable entrance at center bottom of each side.
  - 2. Cover: Concrete composite, weatherproof cover with nonskid finish.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. See Division 01 – General Requirements.
- B. Verify outlet locations and routing and termination locations of raceway prior to rough-in.

### 3.2 INSTALLATION

- A. Ground and bond raceway and boxes in accordance with Section 26 0526.
- B. Fasten raceway and box supports to structure and finishes in accordance with Section 28 0529.
- C. Identify raceway and boxes in accordance with Section 28 0553.
- D. Arrange raceway and boxes to maintain headroom and present neat appearance.

3.3 INSTALLATION - RACEWAY

- A. Raceway routing is shown in approximate locations unless dimensioned. Route to complete wiring system.
- B. Arrange raceway supports to prevent misalignment during wiring installation.
- C. Support raceway using coated steel or malleable iron straps, lay-in adjustable hangers, clevis hangers, and split hangers.
- D. Group related raceway; support using conduit rack. Construct rack using steel channel specified in Section 28 0529; provide space on each for 25 percent additional raceways.
- E. Do not support raceway with wire or perforated pipe straps. Remove wire used for temporary supports
- F. Do not attach raceway to ceiling support wires or other piping systems.
- G. Construct wireway supports from steel channel specified in Section 26 0529.
- H. Route exposed raceway parallel and perpendicular to walls.
- I. Route raceway installed above accessible ceilings parallel and perpendicular to walls.
- J. Route conduit under slab from point-to-point.
- K. Maintain clearance between raceway and piping for maintenance purposes.
- L. Maintain 12 inch clearance between raceway and surfaces with temperatures exceeding 104 degrees F.
- M. Cut conduit square using saw or pipe cutter; de-burr cut ends.
- N. Bring conduit to shoulder of fittings; fasten securely.
- O. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes.
- P. Install conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
- Q. Install no more than equivalent of three 90 degree bends between boxes. Install conduit bodies to make sharp changes in direction, as around beams. Install factory elbows for bends in metal conduit larger than 2 inch size.
- R. Avoid moisture traps; install junction box with drain fitting at low points in conduit system.



- S. Install fittings to accommodate expansion and deflection where raceway crosses seismic, control and expansion joints.
- T. Install suitable pull string or cord in each empty raceway except sleeves and nipples.
- U. Install suitable caps to protect installed conduit against entrance of dirt and moisture.
- V. Surface Raceway: Install flat-head screws, clips, and straps to fasten raceway channel to surfaces; mount plumb and level. Install insulating bushings and inserts at connections to outlets and corner fittings.
- W. Close ends and unused openings in wireway.

#### 3.4 INSTALLATION - BOXES

- A. Install wall mounted boxes at elevations to accommodate mounting heights as specified in section for outlet device.
- B. Coordinate communications device locations with furniture plan and receptacle locations to accommodate the intended purpose prior to rough-in.
- C. Adjust box location up to 10 feet prior to rough-in to accommodate intended purpose.
- D. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- E. In Accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panel or from removable recessed luminaire.
- F. Locate flush mounting box in masonry wall to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat opening.
- G. Do not install flush mounting box back-to-back in walls; install with minimum 6 inches separation. Install with minimum 24 inches separation in acoustic rated walls.
- H. Secure flush mounting box to interior wall and partition studs. Accurately position to allow for surface finish thickness.
- I. Install stamped steel bridges to fasten flush mounting outlet box between studs.
- J. Install flush mounting box without damaging wall insulation or reducing its effectiveness.
- K. Install adjustable steel channel fasteners for hung ceiling outlet box.
- L. Do not fasten boxes to ceiling support wires or other piping systems.
- M. Support boxes independently of conduit.

- N. Install gang box where more than one device is mounted together. Do not use sectional box.
  - O. Install gang box with plaster ring for single device outlets.
- 3.5 INTERFACE WITH OTHER PRODUCTS
- A. Install conduit to preserve fire resistance rating of partitions and other elements, using materials and methods in accordance with Division 07 Section “Penetration Firestopping”.
  - B. Route conduit through roof openings for piping and ductwork or through suitable roof jack with pitch pocket.
  - C. Locate outlet boxes to allow luminaires positioned as indicated on Drawings.
  - D. Align adjacent wall mounted outlet boxes for switches, thermostats, and similar devices.
- 3.6 ADJUSTING
- A. See Division 01 – General Requirements.
  - B. Adjust flush-mounting outlets to make front flush with finished wall material.
  - C. Install knockout closures in unused openings in boxes.
- 3.7 CLEANING
- A. See Division 01 – General Requirements.
  - B. Clean interior of boxes to remove dust, debris, and other material.
  - C. Clean exposed surfaces and restore finish.

END OF SECTION 280533

SECTION 280553 - IDENTIFICATION FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Nameplates.
  - 2. Labels.
  - 3. Wire markers.
  - 4. Conduit markers.
  - 5. Underground Warning Tape.
  - 6. Lockout Devices.
  
- B. Related Sections:
  - 1. See Division 09 - Execution requirements for painting specified by this section.
  - 2. Section 26 0553 - Identification for Electrical Systems.
  - 3. Section 27 0553 - Identification for Communications Systems.

1.2 SUBMITTALS

- A. See Division 01 – General Requirements.
  
- B. Product Data:
  - 1. Submit manufacturer’s catalog literature for each product required.
  - 2. Submit electrical identification schedule including list of wording, symbols, letter size, color coding, tag number, location, and function.
  
- C. Manufacturer's Installation Instructions: Indicate installation instructions, special procedures, and installation.

1.3 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
  
- B. Project Record Documents: Record actual locations of tagged devices; include tag numbers.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. See Division 01 – General Requirements.
  
- B. Accept identification products on site in original containers. Inspect for damage.
  
- C. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.

- D. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

## 1.5 ENVIRONMENTAL REQUIREMENTS

- A. See Division 01 – General Requirements.
- B. Install labels only when ambient temperature and humidity conditions for adhesive are within range recommended by manufacturer.

## PART 2 PRODUCTS

### 2.1 NAMEPLATES

- A. Manufacturers:
  - 1. Seton.
  - 2. Brady.
  - 3. Ideal Industries
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Laminated three-layer plastic with engraved white letters on black contrasting background color.
- C. Letter Size:
  - 1. 1/8 inch high letters for identifying individual equipment and loads.
  - 2. 1/4 inch high letters for identifying grouped equipment and loads.
- D. Minimum nameplate thickness: 1/8 inch.

### 2.2 LABELS

- A. Manufacturers:
  - 1. Seton.
  - 2. Brady.
  - 3. Ideal Industries
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Labels: Embossed, pre-printed adhesive tape, with 3/16 inch white letters on black background.

### 2.3 WIRE MARKERS

- A. Manufacturers:
  - 1. Seton.
  - 2. Brady.
  - 3. Ideal Industries
  - 4. Substitutions: See Division 01 - General Requirements.

- B. Description: Cloth tape or split sleeve type wire markers.
- C. Legend:
  - 1. Power and Lighting Circuits: Branch circuit or feeder number as indicated on Drawings.
  - 2. Control Circuits: Control wire number as indicated on shop drawings.

#### 2.4 CONDUIT AND RACEWAY MARKERS

- A. Manufacturers:
  - 1. Seton.
  - 2. Brady.
  - 3. Ideal Industries
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Description: Nameplate fastened with straps.
- C. Color:
  - 1. Fire Alarm System: Red lettering on white background.
  - 2. Security System (Access Control, Intrusion Detection & Video Surveillance): White lettering on black background.
- D. Legend:
  - 1. Fire Alarm System: FIRE ALARM.
  - 2. Access Control System: ACCESS CONTROL.
  - 3. Intrusion Detection: ALARM.
  - 4. Video surveillance: CCTV.

#### 2.5 LOCKOUT DEVICES

- A. Lockout Hasps:
  - 1. Manufacturers:
    - a. Master Lock.
    - b. Ideal Industries.
    - c. Brady.
    - d. Substitutions: Section 01 60 00 - Product Requirements.
  - 2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches.

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 09 for stencil painting.

3.2 INSTALLATION

- A. Install identifying devices after completion of painting.
- B. Nameplate Installation:
  - 1. Install nameplate parallel to equipment lines.
  - 2. Install nameplate for each electrical distribution and control equipment enclosure with corrosive-resistant mechanical fasteners.
  - 3. Install nameplates for each control panel and major control components located outside panel with corrosive-resistant mechanical fasteners.
  - 4. Secure nameplate to equipment front using screws.
  - 5. Install nameplates for the following:
    - a. Equipment racks and cabinets.
- C. Label Installation:
  - 1. Labeling procedures shall meet TIA/EIA 568B Series standard and BICSI Standards and shall be pre-approved by the Architect.
  - 2. Permanently label, using pre-printed labels, all cables and terminations.
    - a. Patch panels and cross-connect blocks, numerically from top to bottom.
    - b. Patch panel port with work area outlet label.
    - c. Cable segments.
  - 3. Install label parallel to equipment lines.
  - 4. Use industry standard TIA/EIA and BICSI color codes.
- D. Wire Label Installation:
  - 1. Mark data cabling at each end. Install additional marking at accessible locations along the cable run.
  - 2. Install labels at data outlets identifying patch panel and port designation as specified.
- E. Conduit Marker Installation:
  - 1. Install conduit marker for each conduit longer than 10 feet.
  - 2. Conduit Marker Spacing: 20 feet on center.

END OF SECTION 280553

## SECTION 283100 FIRE DETECTION AND ALARM

### PART 1 GENERAL

#### 1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."
- B. Section 019113 – General Commissioning Requirements and related specification sections apply.
- C. Section 017419 - Construction and Demolition Waste Management and Disposal.
- D. Section 018113 - Sustainable Design Requirements.
- E. Section 018119 - Construction Indoor Air Quality Requirements.

#### 1.2 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification
- B. LEED v4 Submittals: For all interior, wet-applied adhesives, sealants, paints and coatings related to the work of this Section, submit product and material documentation as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

#### 1.3 DESCRIPTION:

- A. Main Building: This section of the specification includes the furnishing, installation, connection and testing of a microprocessor control, intelligent reporting fire alarm equipment required to form a complete, operative, coordinated system. It shall include, but not be limited to, installation, connection and testing of the microprocessor controlled Fire Alarm control panel, alarm initiating devices, alarm notification appliances, Fire Alarm Remote Control Panels, auxiliary control devices, annunciator, and wiring as shown on the drawings and specified herein.
- B. Garage: The intent of this work includes the furnishing, installation, connection and testing of the microprocessor controlled, intelligent reporting fire alarm equipment

required to form a complete, operative, coordinated system. It shall include, but not be limited to, alarm initiating devices, alarm notification appliances, Fire Alarm Control Panel (FACP), control devices, annunciators, and wiring as shown on the drawings and specified herein. Devices in unconditioned spaces shall be rated for low temperature operation to maintain operation during unoccupied periods.

- C. The fire alarm system shall comply with requirements of NFPA Standard 72 for Protected Premises Signaling Systems except as modified and supplemented by this specification. The system shall be electrically supervised and monitor the integrity of all conductors.
- D. The fire alarm manufacturer shall be of the highest caliber and insist on the highest quality. The system shall be manufactured by an ISO 9001 certified company and meet the requirements of BS EN9001: ANSI/ASQC Q9001-1994.
- E. The FACP and peripheral devices shall be manufactured 100% by a single U.S. manufacturer (or division thereof).
- F. The system and its components shall be Underwriters Laboratories, Inc. listed under the appropriate UL testing standard as listed herein for fire alarm applications and shall be in compliance with the UL listing.

#### 1.4 DEFINITIONS:

- A. Initiation Device: A manual or automatic operated device that when operated results in the transmission of a fire alarm or supervisory indication at the control panel.
  - 1. Common alarm initiation devices include:
    - a. Smoke detectors.
    - b. Heat detectors.
    - c. Multi-criteria detectors.
    - d. Manual pull stations.
    - e. Water flow devices.
    - f. Fire suppression system switches.
  - 2. Common supervisory initiation devices include:
    - a. Valve position (tamper) switches.
    - b. Water levels witches.
    - c. Hi/Low pressure switches.
    - d. Fire suppression system trouble switches.
    - e. Carbon Monoxide detectors.

#### 1.5 RELATED SECTIONS

- A. Related Sections:
  - 1. Division 01 Section – Cutting and patching
  - 2. Division 07 Section – Penetration Fire stopping.
  - 3. Section 26 05 26 – Grounding and Bonding for Electrical Systems.
  - 4. Section 28 05 29 – Hangers and Supports for Electronic Safety and Security.
  - 5. Section 28 05 53 – Identification for Electronic Safety and Security.



1.6 SCOPE:

- A. New fire alarm equipment shall be installed in accordance to the project specifications and drawings.
- B. Record Document Cabinet: Provide a lockable fire alarm document cabinet to store system record documents. Documents stored in cabinet shall include, but not be limited to: As-Built drawings; service records; inspection and testing documents; software and manuals. Where remotely located, provide signage at the FACP indicating location of the record cabinet.
- C. Basic Performance:
  - 1. Alarm, trouble and supervisory signals from all intelligent reporting devices shall be encoded on NFPA Style 4 (Class B) Signaling Line Circuits (SLC).
  - 2. Initiation Device Circuits (IDC) shall be wired Class A (NFPA Style D) as part of an addressable device connected by the SLC Circuit.
  - 3. Notification Appliance Circuits (NAC) shall be wired Class B (NFPA Style Y) as part of an addressable device connected by the SLC Circuit.
  - 4. Digitized electronic signals shall employ check digits or multiple polling.
  - 5. A single ground or open on the system signaling line circuit shall not cause system malfunction, loss of operating power or the ability to report an alarm.
  - 6. Alarm signals arriving at the main FACP shall not be lost following a primary power failure (or outage) until the alarm signal is processed and recorded.
  - 7. NAC circuits shall be arranged such that there is a minimum of one circuit per floor of the building or smoke zones whichever is greater.
  - 8. NAC circuits and control equipment shall be arranged such that loss of any one (1) circuit will not cause the loss of any other circuit in the system.
- D. BASIC SYSTEM FUNCTIONAL OPERATION

When a fire alarm condition is detected and reported by one of the system initiating devices, the following functions shall immediately occur:

- 1. The system alarm LED on the FACP shall flash.
- 2. A local piezo electric signal in the control panel shall sound.
- 3. A backlit 80 character LCD display on the FACP shall indicate all information associated with the fire alarm condition, including the type of alarm point and its location within the protected premises.
- 4. In response to a fire alarm condition, the system will process all control programming and activate all system outputs (alarm notification appliances and/or relays) associated with the point(s) in alarm.
- 5. Remote receiving station shall be notified automatically.

1.7 SUBMITTALS

- A. General:
  - 1. Ten copies of all submittals shall be submitted to the Architect/Engineer for review.

2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality.
- B. Shop Drawings:
1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
  3. Show annunciator layout, configurations, and terminations.
  4. Provide battery calculations as described in Part 2 of this specification under "Batteries".
- C. Manuals:
1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets
  2. Maintenance and instruction manuals shall be submitted per Division 01 – General Requirements.
  3. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
  4. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.
- D. Certifications:
1. Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.

#### 1.8 GUARANTY:

- A. All work performed and all material and equipment furnished under this contract shall be free from defects and shall remain so for a period of at least one (1) year from the date of acceptance. The full cost of maintenance, labor and materials required to correct any defect during this one year period shall be included in the submittal bid.

#### 1.9 APPLICABLE STANDARDS AND SPECIFICATIONS:

The specifications and standards listed below form a part of this specification. The system shall fully comply with the latest issue of these standards.

- A. National Fire Protection Association (NFPA) – USA:
- |               |                                     |
|---------------|-------------------------------------|
| No. 12        | CO2 Extinguishing Systems           |
| No. 12A & 12B | Halon Extinguishing Systems         |
| No. 15        | Water Spray Systems                 |
| No. 16        | Foam/Water Deluge and Spray Systems |

No. 72-1993	National Fire Alarm Code
No. 101	Life Safety Code Underwriters Laboratories Inc. (UL) – USA:
No. 268	Smoke Detectors for Fire Protective Signaling Systems
No. 864	Control Units for Fire Protective Signaling Systems
No. 268A	Smoke Detectors for Duct Applications
No. 521	Heat Detectors for Fire Protective
No. 464	Audible Signaling Appliances
No. 38	Manually Actuated Signaling Boxes
No. 346	Waterflow Indicators for Fire Protective Signaling Systems
No. 1076	Control Units for Burglar Alarm Proprietary Protective Signaling Systems
No. 1971	Visual Notification Appliances

- B. Local and State Building Codes.
- C. All requirements of the Authority Having Jurisdiction (AHJ).
- D. Distributor of fire alarm to be an approved UUJS certified company.

1.10 APPROVALS:

- A. The system shall have proper listing and/or approval from the following nationally recognized agencies:
  - UL Underwriters Laboratories Inc.
  - FM Factory Mutual
- B. The fire alarm control panel shall meet UL Standard 864 (Control Units) and UL Standard 1076 (Proprietary Burglar Alarm Systems).

1.11 MAINTENANCE MATERIALS

- A. Division 01 – General Requirements.
- B. Furnish three manual station break-glass rods.
- C. Furnish six keys of each type.
- D. Provide (2) manual fire alarm pull stations, complete with all labor, material, and programming, to be located in the field as directed by the Local Authority Having Jurisdiction.
- E. Provide (2) fire alarm audio/visual appliances, complete with all labor, material, and programming, to be located in the field as directed by the Local Authority having Jurisdiction.

1.12 EXTRA MATERIALS

- A. See Division 01 – General Requirements.

- B. Provide (2) manual fire alarm pull stations.
- C. Provide (2) fire alarm audio/visual appliances of each type.

## PART 2 PRODUCTS

### 2.1 EQUIPMENT AND MATERIAL, GENERAL:

- A. All equipment and components shall be new, and the manufacturer's current model. The materials, appliances, equipment and devices shall be tested and listed by a nationally recognized approvals agency for use as part of a protective signaling system, meeting the National Fire Alarm Code.
- B. All equipment and components shall be installed in strict compliance with manufacturers' recommendations. Consult the manufacturer's installation manuals for all wiring diagrams, schematics, physical equipment sizes, etc., before beginning system installation.
- C. All equipment shall be attached to walls and ceiling/floor assemblies and shall be held firmly in place (e.g., detectors shall not be supported solely by suspended ceilings). Fasteners and supports shall be adequate to support the required load.
- D. *All equipment proposed is based on Notifier or approved equal.*

### 2.2 CONDUIT AND WIRE:

- A. Metal Clad (MC) Cable:
  - 1. Type FPLP cable with galvanized interlocking steel with continuous red stripe.
  - 2. NEC Article 760 rating for fire alarm control cables.
  - 3. Install multiconductor cabling in accordance with NEC article 730.
  - 4. Use permitted above accessible ceilings for ceiling mount devices within room or concealed within or channeled in walls. Provide conduit and wire for final homeruns to control panels, and power supplies.
  - 5. Conductors shall comply with paragraph C.
- B. Conduit:
  - 1. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.
  - 2. Where exposed, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
  - 3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
  - 4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient

suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
6. Conduit shall be 3/4 inch (19.1 mm) minimum.

C. Wire:

1. All fire alarm system wiring shall be new.
2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for initiating device circuits and signaling line circuits, and 14 AWG (1.63 mm) for notification appliance circuits.
3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
5. Wiring used for the SLC multiplex communication loop shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. In certain applications, the system shall support up to SLC loops with up to 1,000 feet of untwisted, unshielded wire. The system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication loop.
6. All field wiring shall be completely supervised.
7. The fire alarm control panel shall be capable of t-tapping Class B (NFPA Style 4) Signaling Line Circuits (SLCs). Systems which do not allow or have restrictions in, for example, the amount of t-taps, length of t-taps etc., are not acceptable.

D. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

E. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.

F. The fire alarm control panel shall be connected to separate dedicated branch circuit, maximum 20 amperes. This circuit shall be labeled at the main power distribution panel as FIRE ALARM. Fire alarm control panel primary power wiring shall be 12 AWG. The control panel cabinet shall be grounded securely to either a cold water pipe or grounding rod.

### 2.3 MAIN BUILDING FIRE ALARM CONTROL PANEL:

A. The specification is based on a Notifier Model NFSW2-100 main control panel. The system shall contain a microprocessor based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, annunciators, and other system controlled devices.

- B. Operator Control:
1. Acknowledge Switch:
    - a. Activation of the control panel acknowledge switch in response to new alarms and/or troubles shall silence the local panel piezo electric signal and change the alarm and trouble LEDs from flashing mode to steady-ON mode. If multiple alarm or trouble conditions exist, depression of this switch shall advance the 80-character LCD display to the next alarm or trouble condition.
    - b. Depression of the Acknowledge switch shall also silence all remote annunciator piezo sounders.
  2. Alarm Silence Switch:
    - a. Activation of the alarm silence switch shall cause all programmed alarm notification appliances and relays to return to the normal condition after an alarm condition. The selection of notification circuits and relays that are silence able by this switch shall be fully field programmable within the confines of all applicable standards. The FACP software shall include silence inhibit and auto-silence timers.
  3. Alarm Activate (Drill) Switch:
    - a. The Alarm Activate switch shall activate all notification appliance circuits. The drill function shall latch until the panel is silenced or reset.
  4. System Reset Switch:
    - a. Activation of the System Reset switch shall cause all electronically-latched initiating devices, appliances or software zones, as well as all associated output devices and circuits, to return to their normal condition.
  5. Lamp Test:
    - a. The Lamp Test switch shall activate all system LEDs and light each segment of the liquid crystal display.
- C. System Capacity and General Operation:
1. The control panel shall provide, or be capable of expansion to 198 intelligent/addressable devices.
  2. The control panel shall include Form-C Alarm, Trouble and Supervisory relays rated at a minimum of 2.0 amps @ 30 VDC. It shall also include programmable Notification Appliance Circuits (NACs) capable of being wired as Class B (NFPA Style Y) or Class A (NFPA Style Z).
  3. The fire alarm control panel shall include an operator interface control and annunciation panel that shall include a backlit Liquid Crystal Display (LCD), individual color-coded system status LEDs, and an alphanumeric keypad for the field programming and control of the fire alarm system.
  4. All programming or editing of the existing program in the system shall be achieved without special equipment and without interrupting the alarm monitoring functions of the fire alarm control panel. The system shall be fully programmable, configurable, and expandable in the field without the need for special tools, PROM programmers or PC based programmers. It shall not require replacement of memory ICs to facilitate programming changes. The control unit will support the ability to upgrade its operating program using FLASH memory technology. The unit shall provide the user with the ability to program from either the included keypad, a standard PS2-style PC keyboard or from a computer running upload/download software.

5. The system shall allow the programming of any input to activate any output or group of outputs. Systems which have limited programming (such as general alarm), have complicated programming (such as a diode matrix), or REQUIRE a laptop personal computer are not considered suitable substitutes.
  6. The FACP shall provide the following features:
    - a. Drift compensation to extend detector accuracy during the accumulation of dust and foreign material.
    - b. Detector sensitivity test, meeting requirements of NFPA 72, Maintenance alert, with two levels (maintenance alert/maintenance urgent), to warn of excessive smoke detector dirt or dust accumulation.
    - c. The ability to display or print system reports.
    - d. Alarm verification.
    - e. Positive Alarm Sequence (PAS presignal), meeting NFPA 72 (2002 Edition) 6.8.1.3 requirements
    - f. Rapid manual station reporting.
    - g. Non-alarm points for general (non-fire) control.
    - h. Periodic detector test, conducted automatically by the software.
    - i. Walk test, with a check for two detectors set to same address.
  7. The FACP shall be capable of coding Notification Appliance Circuits in March Time Code (120 PPM), Temporal (NFPA 72), and California Code. Main panel notification circuits (NACs 1 & 2) shall also automatically synchronize the following manufacturer's notification appliances connected to them: System Sensor, Wheelock, or Gentex with no need for additional synchronization modules.
- D. Central Microprocessor
1. The microprocessor shall be a state-of-the-art; high speed device and it shall communicate with, monitor and control all external interfaces. It shall include an EPROM for system program storage, non-volatile memory for building-specific program storage, and a "watch dog" timer circuit to detect and report microprocessor failure.
  2. The microprocessor shall contain and execute all specific actions to be taken in the condition of an alarm. Control programming shall be held in non-volatile programmable memory, and shall not be lost even if system primary and secondary power failure occurs.
  3. The microprocessor shall also provide a real-time clock for time annotation of system displays, printer, and history file.
  4. A special program check function shall be provided to detect common operator errors.
  5. An auto-programming capability (self-learn) shall be provided to quickly identify devices connected on the SLC and make the system operational.
  6. For flexibility and to ensure program validity, an optional Windows(TM) based program utility shall be available. This program shall be used to off-line program the system with batch upload/download. This program shall also have a verification utility which scans the program files, identifying possible errors. It shall also have the ability to compare old program files to new ones, identifying differences in the two files to allow complete testing of any system operating changes. This shall be in compliance with the NFPA 72 requirements for testing after system modification.



- E. Local Keyboard Interface
1. In addition to an integral keypad, the fire alarm control panel will accept a standard PS2-style keyboard for programming, testing, and control of the system. The keyboard will be able to execute the system functions ACKNOWLEDGE, SIGNALS SILENCED, DRILL and RESET.
- F. Display
1. The display shall provide all the controls and indicators used by the system operator and may also be used to program all system operational parameters.
  2. The display shall include status information and custom alphanumeric labels for all intelligent detectors, addressable modules, internal panel circuits, and software zones.
  3. The display shall contain an alphanumeric, text-type display and dedicated LEDs for the annunciation of AC POWER, FIRE ALARM, SUPERVISORY, TROUBLE, MAINTENANCE, ALARM SILENCED, DISABLED, BATTERY, and GROUND conditions.
  4. The display keypad shall be part of the standard system and have the capability to command all system functions, entry of any alphabetic or numeric information, and field programming. Two different password levels shall be provided to prevent unauthorized system control or programming.
  5. The display shall include the following operator control switches: ACKNOWLEDGE, ALARM SILENCE, DRILL (alarm activate), and SYSTEM RESET.
- G. Signaling Line Circuits (SLC)
1. The SLC interface shall provide power to and communicate with up to 99 intelligent detectors (ionization, photoelectric or thermal) and 99 intelligent modules (monitor or control) for a system capacity of 198 devices. Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
  2. The CPU shall receive information from all intelligent detectors to be processed to determine whether normal, alarm, or trouble conditions exist for each detector. The software shall automatically compensate for the accumulation of dust in each detector up to allowable limits. The information shall also be used for automatic detector testing and for the determination of detector maintenance conditions.
  3. The detector software shall meet NFPA 72 requirements and be certified by UL as a calibrated sensitivity test instrument.
- H. Serial Interfaces
1. The system shall provide a means of interfacing to UL Listed Electronic Data Processing (EDP) peripherals using the EIA-232 communications standard.
  2. One EIA-232 interface shall be used to connect an UL-Listed 80-column printer. The printer shall communicate with the control panel using an interface complying with Electrical Industries Association standard EIA-232D. Power to the printer shall be 120 VAC @ 60 Hz.
- I. The control panel will have the capability of Reverse Polarity Transmission or connection to a Municipal Box for compliance with applicable NFPA standards.



- J. Digital alarm Communicator (DACT). The DACT is an interface for communicating digital information between a fire alarm control panel and a UL-Listed central station.
1. The DACT shall be an integral component of the fire alarm control panel requiring no interconnecting wiring, plug-in module or supervisory circuitry.
  2. The DACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to two different telephone numbers.
  3. The DACT shall be completely field programmable locally from the control panel keypad or via PC software connected to the panel serial port. The DACT shall support upload/download of programming parameters from a remote location over a phone line using upload/download PC software
  4. The DACT shall be capable of transmitting events in Contact ID, SIA 8 and SIA 20 formats. This ensures compatibility with existing and future transmission formats.
  5. Communication shall include vital system status such as:
    - a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
    - b. Independent Addressable Device Status
    - c. AC (Mains) Power Loss
    - d. Low Battery and Earth Fault
    - e. System Off Normal
    - f. 12 and 24-Hour Test Signal
    - g. Abnormal Test Signal (per UL requirements)
    - h. EIA-485 Communications Failure
    - i. Phone Line Failure
  6. The DACT shall support independent zone/point reporting when used in the Contact ID format. In this format, the DACT shall support the transmission of all input addressable points with the system. This format shall enable the central station to have exact details concerning the location of the fire for emergency response.
  7. AN IP Communicator option shall be available to interface to the DACT and be capable of transmitting signals over the internet/intranet or Cellular (GSM) to a compatible receiver.
- K. Enclosures:
1. The control panels shall be housed in a UL-listed cabinet suitable for surface or semi-flush mounting. The cabinet and front shall be corrosion protected, given a rust-resistant prime coat, and manufacturer's standard finish.
  2. The back box and door shall be constructed of .060 steel with provisions for electrical conduit connections into the sides and top.
  3. The door shall provide a key lock and shall include a glass or other transparent opening for viewing of all indicators. For convenience, the door may be selected for either right or left hand hinging.
- L. Power Supplies:
1. The Main Power Supply shall operate on 120/240 VAC, 50/60 Hz, and shall provide all necessary power for the FACP and voice evacuation panels.
  2. The Addressable Main Power Supply shall provide the required power to the CPU using a switching 24 VDC regulator and shall incorporate a battery charger

- for 24 hours of standby power using dual-rate charging techniques for fast battery recharge.
3. The Addressable Main Power Supply shall provide a battery charger for 24 hours of standby using dual-rate charging techniques for fast battery recharge. The supply shall be capable of charging batteries ranging in capacity from 7-200 amp-hours within a 48-hour period.
  4. The Addressable Main Power Supply shall provide a very low frequency sweep earth detect circuit, capable of detecting earth faults.
  5. The Addressable Main Power Supply shall be power-limited per UL864 requirements Fire Fighters' Telephones.
- M. All fire alarm cabinets shall be keyed alike.
- N. Specific System Operations
1. Alarm Verification: Each of the intelligent addressable smoke detectors in the system may be independently programmed for verification of alarm signals. The alarm verification time period shall not exceed 2 minutes.
  2. Point Disable: Any addressable device or conventional circuit in the system may be enabled or disabled through the system keypad.
  3. Point Read: The system shall be able to display the following point status diagnostic functions:
    - a. Device status
    - b. Device type
    - c. Custom device label
    - d. Device zone assignments
  4. System Status Reports: Upon command from an operator of the system, a status report will be generated and printed, listing all system status.
  5. System History Recording and Reporting: The fire alarm control panel shall contain a history buffer that will be capable of storing up to 1000 events. Each of these activations will be stored and time and date stamped with the actual time of the activation. The contents of the history buffer may be manually reviewed, one event at a time, or printed in its entirety.
  6. The history buffer shall use non-volatile memory. Systems that use volatile memory for history storage are not acceptable substitutes.
  7. Automatic Detector Maintenance Alert: The fire alarm control panel shall automatically interrogate each intelligent detector and shall analyze the detector responses over a period of time. If any intelligent detector in the system responds with a reading that is above or below normal limits, then the system will enter the trouble mode, and the particular detector will be annunciated on the system display. This feature shall in no way inhibit the receipt of alarm conditions in the system, nor shall it require any special hardware, special tools or computer expertise to perform.
  8. The fire alarm control panel shall include Silent and Audible Walk Test functions - Silent and Audible. It shall include the ability to test initiating device circuits and Notification Appliance Circuits from the field without returning to the panel to reset the system. The operation shall be as follows:
    - a. The Silent Walk Test will not sound NACs but will store the Walk Test information in History for later viewing.

- b. Alarming an initiating device shall activate programmed outputs, which are selected to participate in Walk Test.
  - c. Introducing a trouble into the initiating device shall activate the programmed outputs.
  - d. Walk Test shall be selectable on a per device/circuit basis. All devices and circuits which are not selected for Walk Test shall continue to provide fire protection and if an alarm is detected, will exit Walk Test and activate all programmed alarm functions.
  - e. All devices tested in walk test shall be recorded in the history buffer.
9. Waterflow Operation
- a. An alarm from a waterflow detection device shall activate the appropriate alarm message on the control panel display; turn on all programmed Notification Appliance Circuits and shall not be affected by the Signal Silence switch.
10. Supervisory Operation
- a. An alarm from a supervisory device shall cause the appropriate indication on the control panel display, light a common supervisory LED, but will not cause the system to enter the trouble mode.
11. Signal Silence Operation
- a. The FACP shall have the ability to program each output circuit (notification circuit or relay) to deactivate upon depression of the Signal Silence switch.
12. Non-Alarm Input Operation
- a. Any addressable initiating device in the system may be used as a non-alarm input to monitor normally open contact type devices. Non-alarm functions are a lower priority than fire alarm initiating devices.

#### 2.4 GARAGE FIRE ALARM CONTROL PANEL:

- A. Manufacturers:
  - 1. Edwards.
  - 2. Notifier.
  - 3. Simplex
  - 4. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description: Modular fire alarm control panel with surface wall-mounted enclosure and shall contain a microprocessor-based Central Processing Unit (CPU). The CPU shall communicate with and control the following types of equipment used to make up the system: intelligent addressable smoke and thermal (heat) detectors, addressable modules, printer, annunciators, and other system controlled devices.
- C. Power supply: Adequate to serve control panel modules, remote detectors, remote annunciators, relays, and alarm signaling devices. Include battery-operated emergency power supply with capacity for operating system in standby mode for 24 hours followed by alarm mode for 5 minutes.
- D. System Supervision: Component or power supply failure places system in trouble mode.

- E. Signaling Line Circuit (SLC)
1. The SLC interface shall provide power to and communicate with up to 50 devices of any type including: intelligent detectors (ionization, photoelectric or thermal), addressable pull stations, intelligent modules (monitor or control). Each SLC shall be capable of NFPA 72 Style 4, Style 6, or Style 7 (Class A or B) wiring.
  2. The CPU shall receive information from all intelligent detectors to be processed to determine whether normal, alarm or trouble conditions exist for each detector. The software shall automatically compensate for the accumulation of dust in each detector up to allowable limits. The information shall also be used for automatic detector testing and for the determination of detector maintenance conditions.
  3. The detector software shall meet NFPA 72 (2002 Edition), Chapter 10 requirements and be certified by UL as a calibrated sensitivity test instrument.
- F. Serial Interfaces:
1. The system shall provide a means of interfacing to UL Listed Electronic Data Processing (EDP) peripherals using the EIA-232 communications standard.
  2. The annunciator RS-485 (ANN-Bus) bus shall also provide connection to additional addressable modules supporting remote 80 character LCD text annunciators that mimic the standard panel display and controls. Said annunciators shall support remote acknowledge, silence, drill and reset functions and shall be enabled via a keyswitch. The bus shall also provide connection to addressable modules supporting up to 40 LEDs for use with a graphic annunciator.
- G. The control panel will have the capability of Reverse Polarity Transmission or connection to a Municipal Box for compliance with applicable NFPA standards.
- H. Digital Alarm Communicator Transmitter (DACT). The DACT is an interface for communicating digital information between a fire alarm control panel and a UL-Listed central station.
1. The DACT shall be an integral component of the fire alarm control panel requiring no interconnecting wiring or supervisory circuitry.
  2. The DACT shall include connections for dual telephone lines (with voltage detect), per UL/NFPA/FCC requirements. It shall include the ability for split reporting of panel events up to two different telephone numbers.
  3. The DACT shall be completely field programmable locally from the control panel keypad or remotely over a phone line using upload/download PC software.
  4. The DACT shall be capable of transmitting events in at least 15 different formats. This ensures compatibility with existing and future transmission formats.
  5. Communication shall include vital system status such as:
    - a. Independent Zone (Alarm, trouble, non-alarm, supervisory)
    - b. Independent Addressable Device Status
    - c. AC (Mains) Power Loss
    - d. Low Battery and Earth Fault
    - e. System Off Normal
    - f. 12 and 24-Hour Test Signal
    - g. Abnormal Test Signal (per UL requirements)

- h. EIA-485 Communications Failure
    - i. Phone Line Failure
  - 6. The DACT shall support independent zone/point reporting when used in the Contact ID format. In this format, the DACT shall support the transmission of up to 50 addressable points with the system. This enables the central station to have exact details concerning the location of the fire for emergency response.
- I. Indicating Appliance Circuits: Supervised signal module, sufficient for signal devices connected to system; occurrence of single ground or open condition places circuit in trouble mode but does not disable circuit from signaling alarm.
- J. Auxiliary Relays: Sufficient SPDT auxiliary relay contacts for each detection zone to provide accessory functions specified.

## 2.5 SYSTEM COMPONENTS:

- A. Alarm Horn: Product Description (Combination Horn & Strobe shall meet the requirements of paragraphs A. & B.): NFPA 72, flush type fire alarm horn with the following features:
  - 1. Sound Rating: 87 dB at 10 feet.
  - 2. Integral strobe lamp and flasher with white lettered "FIRE" on red housing where indicated.
  - 3. Alarm horns for the Garage shall be weatherproof per NEMA 4X, IP56 with an operating temperature of -40 to 150 degrees F.
- B. Strobe lights shall meet the requirements of the ADA, UL Standard 1971, NFPA 2010 and shall meet the following criteria:
  - 1. The pulse duration shall be between minimum of one second and maximum of two seconds.
  - 2. Strobe intensity shall meet the requirements of UL 1971, NFPA 2010 and ADA.
  - 3. All visual units shall be synchronized to meet ADA requirements using sync modules.
  - 4. Alarm strobes for the Garage shall be weatherproof per NEMA 4X, IP56 with an operating temperature of -40 to 150 degrees F.
- C. Alphanumeric LCD Type Annunciator
  - 1. The alphanumeric display annunciator shall be a supervised, remotely located back-lit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
  - 2. The LCD annunciator shall display all alarm and trouble conditions in the system.
  - 3. An audible indication of alarm shall be integral to the alphanumeric display.
  - 4. The display shall be UL listed for fire alarm application.
  - 5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6000 feet from the control panel.
  - 6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.

7. Provide annunciator key switch to enable or disable operation of annunciator membrane control switches.
- D. All interfaces and associated equipment are to be protected so that they will not be affected by voltage surges or line transients consistent with UL standard 864.
- E. Field Wiring Terminal Blocks
1. For ease of service all panel I/O wiring terminal blocks shall be removable, plug-in types and have sufficient capacity for 18 to 12 AWG wire. Terminal blocks which are permanently fixed are not acceptable.

## 2.6 SYSTEM COMPONENTS – ADDRESSABLE DEVICES

- A. Addressable Devices – General
1. Addressable devices shall employ the simple-to-set decade addressing scheme. Addressable devices which use a binary-coded address setting method, such as a DIP switch, are not an allowable substitute.
  2. Detectors shall be addressable and intelligent, and shall connect with two wires to the fire alarm control panel signaling line circuits.
  3. Addressable smoke and thermal (heat) detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. An output connection shall also be provided in the base to connect an external remote alarm LED.
  4. Detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base options shall include a base with a built-in (local) sounder rated for a minimum of 85 DBA, a relay base and an isolator base designed for Style 7 applications.
  5. Detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel.
  6. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
  7. Detectors shall provide address-setting means using decimal switches.
- B. Addressable Manual Pull Box
1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
  2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
  3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches or larger.
  4. Stations shall be suitable for surface mounting or semi-flush mounting as shown on the plans, and shall be installed not less than 42 inches, nor more than 48 inches above the finished floor.



- C. Garage Low Temperature Manual Pull Box
1. Manufacturers:
    - a. Edwards.
    - b. Notifier.
    - c. Simplex
    - d. Product Description: Manual station with break-glass rod.
  2. Mounting: Semi-Flush.
  3. Type: Non-coded.
  4. Key lock reset with approved outdoor gasket and accompanying outdoor backbox.
  5. UL listed for outdoor applications with sealed switch and gold-plated contacts.
- D. Intelligent Photoelectric Smoke Detector
1. The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
  2. The detectors shall be ceiling-mounted and available in an alternate model with an integral fixed 135-degree heat-sensing element.
  3. Each detector shall contain a remote LED output and a built-in test switch.
  4. Detector shall be provided on a twist-lock base.
  5. It shall be possible to perform a calibrated sensitivity and performance test on the detector without the need for the generation of smoke. The test method shall test all detector circuits.
  6. A visual indication of an alarm shall be provided by dual latching Light Emitting Diodes (LEDs), on the detector, which may be seen from ground level over 360 degrees. These LEDs shall periodically flash to indicate that the detector is in communication with the control panel.
  7. The detector shall not go into alarm when exposed to air velocities of up to 1500 feet per minute (fpm).
  8. The detector screen and cover assembly shall be easily removable for field cleaning of the detector chamber.
  9. All field wire connections shall be made to the base through the use of a clamping plate and screw.
- E. Intelligent Thermal Detectors
1. Thermal detectors shall be intelligent addressable devices rated at 135 degrees Fahrenheit (58 degrees Celsius) and have a rate-of-rise element rated at 15 degrees F (9.4 degrees C) per minute
  2. A high heat thermal detector rated at 190 degrees Fahrenheit shall also be available
  3. The thermal detectors shall connect via two wires to the fire alarm control panel signaling line circuit.
- F. Garage Intelligent Thermal Detector:
1. Product Description: Combination fixed temperature/rate-of rise, spot heat detector as indicated on drawings.
  2. Temperature Rating: 135 degrees F.
  3. Operating temperature: -4 to 150 degrees F.
  4. Rate-of-Rise: 15 degrees F.

- G. Intelligent Duct Smoke Detector
1. The in-duct smoke detector housing shall accommodate either an intelligent ionization detector or an intelligent photoelectric detector, of that provides continuous analog monitoring and alarm verification from the panel.
  2. When sufficient smoke is sensed, an alarm signal is initiated at the FACP, and appropriate action taken to change over air handling systems to help prevent the rapid distribution of toxic smoke and fire gases throughout the areas served by the duct system.
  3. Provide with sampling tubes extending the entire width of the duct.
  4. Provide with keyed remote test/reset switches for **all** duct mounted smoke detectors.
- H. Intelligent Carbon Monoxide (CO) Detector
1. Advanced multi-criteria fire/CO detector shall be an addressable detector, with a separate signal for carbon monoxide (CO) detection. CO detection shall be per UL 2075 standards (complying with alarm threshold standards and sensitivity patterns of UL 2034). The CO detection signal shall report as a supervisory alarm only and shall not activate notification appliance circuits.
  2. The detector shall be comprised of four sensing elements, including a photoelectric (light-scattering) particulate sensor, an electrochemical CO sensor, a daylight-filtered infrared (IR) sensor and solid state thermal sensor(s) rated at 135°F (57.2°C). The device shall be able to indicate distinct smoke and heat alarms.
  3. The advanced multi-criteria detection device shall include the ability to combine the signal of the photoelectric signal with other sensing elements in order to react quickly in the event of a fire situation. It shall also include the inherent ability to distinguish between a fire condition and a nuisance alarm condition. The detector shall be capable of selecting the appropriate sensitivity levels based on the environment type (office, manufacturing, kitchen, etc.) in which it is installed, and then have the ability to automatically change the setting as the environment changes.
  4. The CO detector component shall be capable of a functional gas test using a canned test agent to test the functionality of the CO sensing cell.
  5. The detector shall indicate CO trouble conditions, including six months of sensor life remaining and sensor life has expired. The detector shall indicate a combined signal for any of the following: low chamber trouble, thermistor trouble, CO self test failure, IR self test failure, and freeze warning.
- I. Addressable Dry Contact Monitor Module
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLC loops.
  2. The monitor module shall mount in a 4-inch square, 2-1/8 inch deep electrical box.
  3. The IDC zone may be wired for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.



4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch x 1-1/4 inch x 1/2 inch. This version need not include Style D or an LED.
- J. Addressable Control Module
1. Addressable Relay Modules shall be available for HVAC control and other network building functions.
  2. The module shall provide two form C relays rated at up to 3 Amps resistive and up to 2.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary devices energize at the same time on the same pair of wires.
- K. Record Document Cabinet
1. Provide Space Age Electronics, Inc. FAD series, model SSU00685 red storage cabinet with the following features:
    - a. 16 gauge steel construction with lock and key.
    - b. Solid stainless steel piano hinge for lockable door.
    - c. Dimensions: 12" w x 13" h x 2 1/4" d.
    - d. Permanently screened label with "Fire Alarm Documents" on cover.
    - e. Legend sheet, business card holder and key rings inside.

## 2.7 BATTERIES:

- A. The battery shall have sufficient capacity to power the fire alarm system for not less than twenty-four hours plus 5 minutes of alarm upon a normal AC power failure. Provide battery calculations with the submittals to verify requirements are met.
- B. The batteries are to be completely maintenance free. No liquids are required. Fluid level checks for refilling, spills, and leakage shall not be required.
- C. If necessary to meet standby requirements, external battery cabinet and charger systems may be used.

## PART 3 EXECUTION

### 3.1 INSTALLATION

- A. Installation shall be in accordance with the NEC, NFPA 72, local and state codes, as shown on the drawings, and as recommended by the major equipment manufacturer.
- B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas. Smoke detectors shall not be installed prior to the system programming and test period. If construction is ongoing during this period, measures shall be taken to protect smoke detectors from contamination and physical damage.
- C. All fire detection and alarm system devices, control panels and remote annunciators shall be flush mounted when located in finished areas and may be surface mounted when

located in unfinished areas, or on existing block constructed walls with no means to fish wiring.

- D. Locate intelligent CO detectors as far away from CO source (fossil fuel burning appliance) as practical to minimize false alarms while maintaining manufacturer spacing criteria and NFPA required coverage.
- E. All strobe lights in common viewing spaces shall be synchronized in accordance with NFPA 72 and ADA Guidelines. Provide new strobe lights, synchronization modules and wiring as needed for compliance. Provide synchronization of strobe lights in new and existing spaces where strobe lights are visible from both spaces.
- F. Wall mount duct mounted smoke detector keyed remote test/reset stations at 72" AFF at all duct mount smoke detector location. Wall mount below device and label with address.
- G. Provide permanent signage at the main FACP (inside cover) indicating the location of the fire alarm record document cabinet.
- H. Provide the services of a factory trained and authorized technician to perform all system software modifications, upgrades or changes. Field technicians shall be NICET Level 1 (minimum) certified.
- I. The factory trained technician shall install initial data and artwork at each interactive firefighter's display.
- J. Coordinate interconnection and programming of DACT to Central Monitoring Station of the Owner's choosing.

### 3.2 TEST

- A. The service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment shall be provided to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72, Chapter 7.
  - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
  - 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
  - 3. Verify activation of all water flow switches.
  - 4. Verify supervisory signal on CO detection activation.
  - 5. Open initiating device circuits and verify that the trouble signal actuates.
  - 6. Open and short signaling line circuits and verify that the trouble signal actuates.
  - 7. Open and short notification appliance circuits and verify that trouble signal actuates.
  - 8. Ground all circuits and verify response of trouble signals.
  - 9. Check presence and audibility of tone at all alarm notification devices.
  - 10. Check installation, supervision, and operation of all intelligent smoke detectors using the walk test.

11. Each of the alarm conditions that the system is required to detect should be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control points.
12. When the system is equipped with optional features, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.
13. Coordinate testing of signals with the Central Monitoring Station.

### 3.3 FINAL INSPECTION

- A. At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

### 3.4 INSTRUCTION

- A. Instruction shall be provided as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.
- B. The contractor and/or the systems manufacturer's representatives shall provide a typewritten "Sequence of Operation" to the owner.

END OF SECTION 283100

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## SECTION 311000 - SITE CLEARING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

##### A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removal of invasive species from within the project site.
3. Removing existing vegetation.
4. Stripping and stockpiling existing boulders for reuse.
5. Clearing and grubbing.
6. Stripping and stockpiling duff layer where indicated in drawings.
7. Stripping and stockpiling topsoil.
8. Removing above- and below-grade site improvements.

##### B. Related Requirements:

1. Section 015000 "Temporary Facilities and Controls" for temporary erosion- and sedimentation-control measures.
2. Section 015639 "Temporary Tree and Plant Protection" for Vegetation and Soil Protection Zones.
3. Section 017419 "Construction and Demolition Waste Management and Disposal".
4. Section 018113 "Sustainable Design Requirements"

#### 1.3 DEFINITIONS

- A. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil," but in disturbed areas such as urban environments, the surface soil can be subsoil.
- C. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil; the zone where plant roots grow. Its appearance is generally friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; and free of weeds, roots, toxic materials, or other nonsoil materials.

- D. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- E. Plant-Protection Zone: Area surrounding individual trees, groups of trees, shrubs, or other vegetation to be protected during construction and indicated on Drawings.
- F. Tree-Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and indicated according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- G. Vegetation and Soil Protection Zones: Area designated to be protected from all disturbances throughout the construction process to prevent damage to vegetation, soil structure and function.
- H. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.
- I. Invasive Species: Plant or Animal that is not native to the ecosystem under consideration and that causes or is likely to cause economic or environmental harm or harm to human, animal, or plant health.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.5 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.6 MATERIAL OWNERSHIP

- A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site in conformance with Section 017419.

#### 1.7 ACTION SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the

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Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

- B. Invasive species removal program based on recommendations and best practices of the Connecticut Invasive Plant Working Group (CIPWG) and the Invasive Plant Atlas of New England (IPANE), and other sources as approved.
- C. Duff layer stripping and stockpiling program.
- D. Topsoil stripping and stockpiling program
- E. Rock stockpiling program.

#### 1.8 INFORMATIONAL SUBMITTALS

- A. Existing Conditions: Documentation of existing trees and plantings, adjoining construction, and site improvements that establishes preconstruction conditions that might be misconstrued as damage caused by site clearing.
  - 1. Use sufficiently detailed photographs or video recordings.
  - 2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plant designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.
- C. Burning: No burning will be performed on the project site.

#### 1.9 QUALITY ASSURANCE

- A. Duff layer Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.
- B. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.
- C. Rock Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.

#### 1.10 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing site clearing indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
  - 1. Do not proceed with work on adjoining property until directed by Architect.
- C. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify Call Before You Dig for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- F. Tree- and Plant-Protection Zones: Protect according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- G. Soil Stripping, Handling, and Stockpiling: Perform only when the soil is dry or slightly moist.

#### PART 2 - PRODUCTS

##### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

##### 2.2 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
  - 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.



- B. Antirust Coating: Fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #23 (surface-tolerant, anticorrosive metal primer) or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

### 2.3 INVASIVE SPECIES REMOVAL

- A. Equipment and materials as indicated in the submitted and approved Invasive Species Removal Program.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- C. Protect existing site improvements to remain from damage during construction.
  - 1. Restore damaged improvements to their original condition, as acceptable to Owner.

### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Conform to Section 312500 "Erosion and Sedimentation Controls".

### 3.3 VEGETATION AND SOIL PROTECTION ZONES

- A. Protect trees, plants, and areas of soil structure and function designated to remain on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection."
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations according to requirements in Section 015639 "Temporary Tree and Plant Protection."

### 3.4 INVASIVE SPECIES REMOVAL

- A. As indicated in the submitted and approved Invasive Species Removal Program.

### 3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
  - 1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
  - 2. Grind down stumps and remove roots larger than 2 inches (50 mm) in diameter, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
  - 3. **Use only hand methods or air spade for grubbing within protection zones.**
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
  - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

### 3.6 DUFF LAYER STRIPPING AND STOCKPILING

- A. The duff layer on existing lawn areas (approximately 1 inch or less deep) shall be incorporated into topsoil with the topsoil stripping process.
- B. The duff layer on existing wooded areas (approximately 1 inch to three inches deep) shall, where practical, be stripped and stockpiled separately from topsoil.**
- C. Remove twigs, branches and leaf litter from the surface before stripping the duff layer.
- D. Duff stockpiles shall be narrow, with a maximum height of 3 feet.
- E. Duff stockpiles shall be covered with a woven weed barrier that sheds moisture yet allows airflow.

### 3.7 TOPSOIL STRIPPING AND STOCKPILING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches (150 mm) in a manner to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Topsoil to be respread as planting soil for conservation/wildlife mix and pollinator mix areas shall not be screened.
  - 2. Remove subsoil and nonsoil materials from topsoil to be used as planting soil for lawn turf areas, including clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.

- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.
  - 1. Limit height of topsoil stockpiles to 72 inches (1800 mm).
  - 2. Do not stockpile topsoil within protection zones.
  - 3. Dispose of surplus topsoil. Surplus topsoil is that which exceeds quantity indicated to be stockpiled or reused.
  - 4. Stockpile surplus topsoil to allow for respreading deeper topsoil.

### 3.8 STOCKPILING BOULDERS

- A. Remove from construction area naturally formed rocks currently used as road edge guide that measure more than 1 foot (300 mm) across in least dimension. Do not include excavated or crushed rock.
  - 1. Separate or wash off non-rock materials from rocks, including soil, clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.
- B. Stockpile rock away from edge of excavations without intermixing with other materials. Cover to prevent windblown debris from accumulating among rocks.
  - 1. Limit height of rock stockpiles to 36 inches (900 mm).
  - 2. Do not stockpile rock within protection zones.
  - 3. Dispose of surplus rock. Surplus rock is that which exceeds quantity indicated to be stockpiled or reused.
  - 4. Stockpile surplus rock to allow later use by the Owner.

### 3.9 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.
- B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.
  - 1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut along line of existing pavement to remain before removing adjacent existing pavement. Saw-cut faces vertically.
  - 2. Paint cut ends of steel reinforcement in concrete to remain with two coats of antirust coating, following coating manufacturer's written instructions. Keep paint off surfaces that will remain exposed.

### 3.10 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Conform to Section 017419.

- B. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.
- C. Burning tree, shrub, and other vegetation waste is not permitted.
- D. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials, and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION 311000

SECTION 312000 - EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Report on Geotechnical Engineering Investigation – DEEP West District Headquarters at Black Rock State Park, Watertown, Connecticut – Appendix C Technical Provisions of Specifications for Compacted Structural Fill.

1.2 SUMMARY

- A. Section Includes:
  - 1. Excavating and filling for rough grading the Site.
  - 2. Restoration of disturbed soils on site for a minimum depth of 12”, meeting the requirements of the identified reference soil.
  - 3. Preparing subgrades for slabs-on-grade, walks, pavements, turf and grasses and plants.
  - 4. Base course for concrete walks and pavements.
  - 5. Subbase course and base course for asphalt paving.
  - 6. Subsurface drainage backfill for site seat walls.
- B. Related Requirements:
  - 1. Section 012000 "Contract Considerations".
  - 2. Section 015000 "Temporary Facilities and Controls".
  - 3. Section 015639 "Temporary Tree and Plant Protection" for Vegetation and Soil Protection Zones.
  - 4. Section 017419 "Construction and Demolition Waste Management and Disposal" for the Salvaging, Recycling, Disposing and Demolition requirements of the project.
  - 5. Section 018113 "Sustainable Design Requirements" for the sustainability requirements of this project.
  - 6. Section 311000 "Site Clearing" for site invasive species removal, stripping, grubbing, and stockpiling of boulders, duff and topsoil, and removal of above- and below-grade improvements and utilities.
  - 7. Section 312319 "Dewatering".
  - 8. Section 312333 "Trenching and Backfilling" for trenching and backfilling for utilities.
  - 9. Section 312500 "Erosion and Sedimentation Control".
  - 10. Section 315000 "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
  - 11. Section 329200 "Turf and Grasses" for finish grading in turf and grass areas, including preparing and placing planting soil for turf areas.
  - 12. Section 329300 "Plants" for finish grading in planting areas and tree and shrub pit excavation and planting.
  - 13. Section 330523 "Horizontal Directional Drilling" for directional drilling used for the installation of utilities.

1.3 REFERENCE STANDARDS

- A. Form 817 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction Form 817-2019 or its latest edition and any supplemental specifications.

1.4 UNIT PRICES

- A. Work of this Section is affected by unit prices for earth moving specified in Section 012000 "Contract Considerations" for Unit Prices.
- B. Rock Measurement: Volume of rock actually removed, measured in original position, but not to exceed the following. Unit prices for rock excavation include replacement with approved materials.
  - 1. 24 inches (600 mm) outside of concrete forms other than at footings.
  - 2. 12 inches (300 mm) outside of concrete forms at footings.
  - 3. 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
  - 4. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
  - 5. 6 inches (150 mm) beneath bottom of concrete slabs-on-grade.
  - 6. 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

1.5 DEFINITIONS

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
  - 1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
  - 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.
- E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
  2. Bulk Excavation: Excavation more than 10 feet (3 m) in width and more than 30 feet (9 m) in length.
  3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.
- G. Fill: Soil materials used to raise existing grades.
- H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. (0.76 cu. m) for bulk excavation or 3/4 cu. yd. (0.57 cu. m) for footing, trench, and pit excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Equipment for Footing, Trench, and Pit Excavation: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom.
  2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket.
- I. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material 3/4 cu. yd. (0.57 cu. m) or more in volume that exceed a standard penetration resistance of 100 blows/2 inches (97 blows/50 mm) when tested by a geotechnical testing agency, according to ASTM D1586.
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- K. Subbase Course: Aggregate layer placed between the subgrade and base course for hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- L. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials.
- M. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.
- 1.6 PREINSTALLATION MEETINGS
- A. Preinstallation Conference: Conduct preexcavation conference at Project site.

1. Review methods and procedures related to earthmoving, including, but not limited to, the following:
  - a. Personnel and equipment needed to make progress and avoid delays.
  - b. Coordination of Work with utility locator service.
  - c. Coordination of Work and equipment movement with the locations of tree- and plant-protection zones.
  - d. Extent of trenching by hand or with air spade.
  - e. Field quality control.

#### 1.7 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.8 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
  1. Geotextiles.
  2. Warning tapes.
- B. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- C. Samples for Verification: For the following products, in sizes indicated below:
  1. Geotextile: 12 by 12 inches (300 by 300 mm).
  2. Warning Tape: 12 inches (300 mm) long; of each color.

#### 1.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified testing agency.
- B. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:



1. Classification according to ASTM D2487.
  2. Laboratory compaction curve according to ASTM D1557.
- C. Blasting plan approved by authorities having jurisdiction.
- D. Seismic survey report from seismic survey agency.
- E. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces that might be misconstrued as damage caused by earth-moving operations. Submit before earth moving begins.

#### 1.10 QUALITY ASSURANCE

- A. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code," and prepare a blasting plan reporting the following:
1. Types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
  2. Seismographic monitoring during blasting operations.
- B. Seismic Survey Agency: An independent testing agency, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
  2. Seismographic monitoring during blasting operations.
- C. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E329 and ASTM D3740 for testing indicated.

#### 1.11 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
  2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- B. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner before award of Contract.
1. Do not proceed with work on adjoining property until directed by Architect.

- C. Utility Locator Service: Notify "Call Before You Dig" for area where Project is located before beginning earth-moving operations.
- D. Do not commence earth-moving operations until temporary site fencing and erosion- and sedimentation-control measures specified in Section 015000 "Temporary Facilities and Controls", Section 311000 "Site Clearing" and Section 312500 "Erosion and Sedimentation Controls" are in place.
- E. Do not commence earth-moving operations until plant-protection measures specified in Section 015639 "Temporary Tree and Plant Protection" are in place.
- F. The following practices are prohibited within protection zones:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Foot traffic.
  - 4. Erection of sheds or structures.
  - 5. Impoundment of water.
  - 6. Excavation or other digging unless otherwise indicated.
  - 7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.
- G. Do not direct vehicle or equipment exhaust towards protection zones.
- H. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

## PART 2 - PRODUCTS

### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

### 2.2 REFERENCE SOIL

- A. The reference soil for the project site per the NRCS Web Soil Survey is Hinckley (38A, 38C & 38E). The Hinckley series consists of very deep, excessively drained soils formed in glaciofluvial materials.
  - 1. Hinckley 38A has slopes between 0 and 3 percent.
  - 2. Hinckley 38C has slopes between 3 and 15 percent.
  - 3. Hinckley 38E has slopes between 15 and 35 percent.
- B. Hinckley Soil Texture
  - 1. OE Horizon is moderately decomposed plant materials at a depth of 0 to 1 inch.
  - 2. A Horizon is loamy sand at a depth of 1 to 8"

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3. Bw1 Horizon is gravelly loamy sand at a depth of 8 to 11 inches.
  4. Bw2 Horizon is gravelly loamy sand at a depth of 11 to 16 inches.

C. Hinckley Soil Organic Matter

1. OE Horizon is 95 percent organic matter at a depth of 0 to 1 inch.
2. A Horizon is 5.5 percent organic matter at a depth of 1 to 8”
3. Bw1 Horizon is 0.5 percent organic matter at a depth of 8 to 11 inches.
4. Bw2 Horizon is 0.3 percent organic matter at a depth of 11 to 16 inches.

D. Hinckley Soil Cation Exchange

1. OE Horizon has effective cation exchange of 26-55 at a depth of 0 to 1 inch.
2. A Horizon has effective cation exchange of 0.1 to 6.6 at a depth of 1 to 8”
3. Bw1 Horizon has effective cation exchange of 0.0 to 2.8 at a depth of 8 to 11 inches.
4. Bw2 Horizon has effective cation exchange of 0.0 to 2.1 at a depth of 11 to 16 inches.

E. Hinckley Soil Reaction/pH

1. OE Horizon has a soil reaction/pH of 3.8 to 4.8 at a depth of 0 to 1 inch.
2. A Horizon has a soil reaction/pH of 3.5 to 6.0 at a depth of 1 to 8”
3. Bw1 Horizon has a soil reaction/pH of 3.5 to 6.0 at a depth of 8 to 11 inches.
4. Bw2 Horizon has a soil reaction/pH of 3.5 to 6.0 at a depth of 11 to 16 inches.

F. Hinckley Soil Salinity

1. All horizons have a salinity of 0.0 to 1.9.

## 2.3 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

C. **Restored Soils: Soil material within the top 12 inches of the landscaped and planted surfaces of the site shall be restored to meet the characteristics of the “Reference Soil” indicated in Article 2.2 above.**

1. See section 329115 for soil preparation (performance specifications) to be used for planting soil applications (OE and A Horizons) to depths indicated in the Drawings.

D. Subbase Material: Conform to Form 817, Section 2.12 Subbase and Articles M.02.02 and M.02.06. This material shall consist of reclaimed miscellaneous aggregate.

1. Reclaimed Miscellaneous Aggregate shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free from soft, disintegrated pieces, mud, dirt, glass or other injurious material, and contain no more than 2% by weight of asphalt cement. This reclaimed miscellaneous material shall meet Grading “B” and the requirements for plasticity and resistance to abrasion, which are set forth in M.02.06 of Form 817.

- E. Gravel Base: Conform to Form 817 Article M.02.06 Gradation A. This material shall consist of reclaimed miscellaneous aggregate.
  - 1. Reclaimed Miscellaneous Aggregate material shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free of soft disintegrated pieces, mud, dirt, glass or other injurious materials and contain no more than 2% by weight of asphalt cement. This reclaimed miscellaneous material shall meet Grading “A” and the requirements for plasticity and resistance to abrasion, which are set forth in M.02.06 of Form 817.
- F. Granular Fill: Conform to Form 817, Section 2.13 Granular Fill and Article M.02.01. This material shall consist of reclaimed miscellaneous aggregate.
  - 1. Reclaimed Miscellaneous Aggregate material shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free of soft disintegrated pieces, mud, dirt, glass or other injurious materials and contain no more than 2% by weight of asphalt cement. This reclaimed miscellaneous material shall me Grading “A” and the requirements for plasticity and resistance to abrasion, which are set forth in M.02.06 of Form 817.
- G. Compacted Granular Fill: Conform to Form 817, Section 2.14 Compacted Granular Fill and Article M.02.02.
- H. Granular Base: Conform to Form 817 Article M.02.03 and Article M.02.06 Gradation C. This material shall consist of reclaimed miscellaneous aggregate.
  - 1. Reclaimed Miscellaneous Aggregate material shall consist of sound, tough, durable particles of crushed reclaimed waste. It shall be free of soft disintegrated pieces, mud, dirt, glass or other injurious materials and contain no more than 2% by weight of asphalt cement. This reclaimed miscellaneous material shall meet Grading “A” and the requirements for plasticity and resistance to abrasion, which are set forth in M.02.06 of Form 817.
- I. Processed Aggregate Base: Conform to Form 817 Section 3.04 Processed Aggregate Base and to Article M.05.01. Coarse Aggregate for this material shall consist of reclaimed miscellaneous aggregate.
  - 1. Reclaimed Miscellaneous Aggregate shall consist of sound, tough, durable fragments of uniform quality throughout. It shall be free of soft disintegrated pieces, mud, dirt, glass or other injurious material, and contain no more than 2% by weight of asphalt cement. It shall meet the gradation as set forth in Table M.05.01-1 and the requirements for plasticity in M.05.01 of Form 817.
- J. Controlled Fill: See Report on Geotechnical Engineering Investigation – DEEP West District Headquarters at Black Rock State Park, Watertown, Connecticut – Appendix C Technical Provisions of Specifications for Compacted Structural Fill.
- K. Structural Fill: Conform to Structural Fill as listed in Report on Geotechnical Engineering Investigation – DEEP West District Headquarters at Black Rock State Park, Watertown, Connecticut – Appendix C Technical Provisions of Specifications for Compacted Structural Fill.

- L. Pervious Structure Backfill: See Report on Geotechnical Engineering Investigation – DEEP West District Headquarters at Black Rock State Park, Watertown, Connecticut – Appendix C Technical Provisions of Specifications for Compacted Structural Fill.
- M. 3/8” Crushed Stone: Conform to Form 817, Article M.01.01, No. 8 Stone.
  - 1. Provide washed crushed stone when indicated on the drawings.
- N. 3/4” Crushed Stone: Conform to Form 817, Article M.01.01, No. 6 Stone
  - 1. Provide washed crushed stone when indicated on the drawings.
- O. 1 1/4” Crushed Stone: Conform to Form 817, Article M.01.01, No. 4 Stone.
  - 1. Provide washed crushed stone when indicated on the drawings.
- P. Modified Riprap: Conform to Form 817, Article M.12.02.
- Q. Sand: ASTM C 33/C 33M; fine aggregate.
- R. Stone Dust: Conform to Form 817, Article M.01.01, Screenings.
- S. Free Draining Materials: Conform to Form 817, Article M.02.07. This material shall consist of reclaimed miscellaneous aggregate containing no more than 2% by weight of asphalt cement. This material shall not have more than 70%, by weight, passing the No. 40 mesh sieve and not more than 10%, by weight, passing the No. 200 mesh sieve.

## 2.4 GEOTEXTILES

- A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.
  - 2. Survivability: As follows:
    - a. Grab Tensile Strength: 157 lbf (700 N); ASTM D4632.
    - b. Sewn Seam Strength: 142 lbf (630 N); ASTM D4632.
    - c. Tear Strength: 56 lbf (250 N); ASTM D4533.
    - d. Puncture Strength: 56 lbf (250 N); ASTM D4833.
  - 3. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D4751.
  - 4. Permittivity: 0.5 per second, minimum; ASTM D4491.
  - 5. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.
- B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
  - 1. Survivability: Class 2; AASHTO M 288.

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2. Survivability: As follows:
    - a. Grab Tensile Strength: 247 lbf (1100 N); ASTM D4632.
    - b. Sewn Seam Strength: 222 lbf (990 N); ASTM D4632.
    - c. Tear Strength: 90 lbf (400 N); ASTM D4533.
    - d. Puncture Strength: 90 lbf (400 N); ASTM D4833.
  3. Apparent Opening Size: No. 60 (0.250-mm) sieve, maximum; ASTM D4751.
  4. Permittivity: 0.02 per second, minimum; ASTM D4491.
  5. UV Stability: 50 percent after 500 hours' exposure; ASTM D4355.

## 2.5 ACCESSORIES

- A. Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility; colored as follows:
  1. Red: Electric.
  2. Yellow: Gas, oil, steam, and dangerous materials.
  3. Orange: Telephone and other communications.
  4. Blue: Water systems.
  5. Green: Sewer systems.
- B. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of the utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored as follows:
  1. Red: Electric.
  2. Yellow: Gas, oil, steam, and dangerous materials.
  3. Orange: Telephone and other communications.
  4. Blue: Water systems.
  5. Green: Sewer systems.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

### 3.2 DEWATERING

- A. Conform to Section 312319 “Dewatering”.
- B. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- C. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
  - 1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
- D. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others.

### 3.3 EXPLOSIVES

- A. Explosives: Obtain written permission from authorities having jurisdiction before bringing explosives to Project site or using explosives on Project site.
  - 1. Perform blasting without damaging adjacent structures, property, or site improvements.
  - 2. Perform blasting without weakening the bearing capacity of rock subgrade and with the least-practicable disturbance to rock to remain.

### 3.4 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.
  - 2. Remove rock to lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
    - a. 24 inches (600 mm) outside of concrete forms other than at footings.
    - b. 12 inches (300 mm) outside of concrete forms at footings.
    - c. 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
    - d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
    - e. Bottom elevation of the specified base or subbase course beneath bottom of concrete slabs-on-grade.



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- f. 6 inches (150 mm) beneath pipe in trenches and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.
  - g. 48" below finish elevations shown on drawings for tree planting area at a width of the plant excavation plus 12" all around
  - h. 24" below indicated finish elevations shown on drawings for shrub planting area at a width of the plant excavation plus 12" all around.
  - i. 6" below finish elevations shown on drawings for lawn planting area at a width of the planting area plus 18" all around.

### 3.5 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch (25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
  - 2. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
  - 3. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch (25 mm). Do not disturb bottom of excavations intended as bearing surfaces.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
  - 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
  - 2. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

### 3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Conform to Section 312333 "Trenching and Backfilling" for excavating, backfilling and compacting for utilities.



### 3.8 SUBGRADE INSPECTION

- A. Notify Architect when excavations have reached required subgrade.
- B. If Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.
- C. Proof-roll subgrade below the building slabs and pavements with a pneumatic-tired and loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes) to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
  - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
  - 2. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.
- D. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- E. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

### 3.9 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi (17.2 MPa), may be used when approved by Architect.
  - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Architect.

### 3.10 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.11 BACKFILL

- A. Place and compact backfill in excavations promptly, but not before completing the following:
  - 1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.

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2. Surveying locations of underground utilities for Record Documents.
  3. Testing and inspecting underground utilities.
  4. Removing concrete formwork.
  5. Removing trash and debris.
  6. Removing temporary shoring, bracing, and sheeting.
  7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

- B. Place backfill on subgrades free of mud, frost, snow, or ice.

### 3.12 UTILITY TRENCH BACKFILL

- A. Conform to Section 312333 “Trenching and Backfilling” for excavating, backfilling and compacting for utilities.

### 3.13 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

- B. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

- C. Place soil fill on subgrades free of mud, frost, snow, or ice.

### 3.14 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

### 3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches (200 mm) in loose depth for material compacted by heavy compaction equipment and not more than 4 inches (100 mm) in loose depth for material compacted by hand-operated tampers.

- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D1557:
  - 1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches (300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.
  - 2. Under walkways, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
  - 3. Under turf or unpaved areas, scarify and recompact top 6 inches (150 mm) below subgrade and compact each layer of backfill or fill soil material at 85 percent.
  - 4. For deep fill slopes:
    - a. Fill in 8" lifts maximum.
    - b. Upper 6' of fill compact each layer of backfill or fill material at 95 percent.
    - c. Fill below the upper 6' of fill, compact each layer of backfill or fill material at 93 percent.
  - 5. For utility trenches, compact each layer of initial and final backfill soil material at 85 percent.

### 3.16 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
  - 1. Provide a smooth transition between adjacent existing grades and new grades.
  - 2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
  - 1. Turf or Unpaved Areas: Plus or minus 1 inch (25 mm).
  - 2. Walks: Plus or minus 1 inch (25 mm).
  - 3. Pavements: Plus or minus 1/2 inch (13 mm).
- C. Cut Slope Grading: After final grading and prior to placement of planting soils, cut slopes shall be cross-ripped horizontal to the slope to assist in anchoring the planting soil.
  - 1. The spacing of the ripping shanks shall be 3 feet and penetration should not exceed 12 inches in depth.
- D. Constructed Slope Grading: Where embankments are constructed, offsetting lifts of material to create an uneven surface prior to topsoil placement should be considered to assist in anchoring the planting soil.

- E. Restoring Infiltration Capacity and Aeration to Compacted Soils: Prior to placing planting soils, subsoil shall be scarified to a minimum depth of 12" from the proposed finished surface elevation. Soil shall be loosened but not turned or inverted.
  - 1. For slope areas, scarification should be uneven in depth.
  - 2. Avoid existing tree roots where present.

### 3.17 SUBSURFACE DRAINAGE

- A. Subdrainage Pipe: Specified in Section 334000 "Storm Sewer Utilities."
- B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch (150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches (300 mm) of filter material, placed in compacted layers 6 inches (150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
  - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D1557 with a minimum of two passes of a plate-type vibratory compactor.
- C. Drainage Backfill: Place and compact filter material over subsurface drain, in width indicated, to within 12 inches (300 mm) of final subgrade, in compacted layers 6 inches (150 mm) thick. Overlay drainage backfill with one layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches (150 mm).
  - 1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D1557 with a minimum of two passes of a plate-type vibratory compactor.
  - 2. Place and compact impervious fill over drainage backfill in 6-inch- (150-mm-) thick compacted layers to final subgrade.

### 3.18 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course and base course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
  - 1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
  - 2. Place base course material over subbase course under hot-mix asphalt pavement.
  - 3. Shape subbase course and base course to required crown elevations and cross-slope grades.
  - 4. Place subbase course and base course 6 inches (150 mm) or less in compacted thickness in a single layer.
  - 5. Place subbase course and base course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.

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6. Compact subbase course and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D1557.

### 3.19 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
  2. Determine that fill material classification and maximum lift thickness comply with requirements.
  3. Determine, during placement and compaction, that in-place density of compacted fill complies with requirements.
- B. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- D. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.
- E. Testing agency will test compaction of soils in place according to ASTM D1556, ASTM D2167, ASTM D2937, and ASTM D6938, as applicable. Tests will be performed at the following locations and frequencies:
  1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. (186 sq. m) or less of paved area or building slab but in no case fewer than three tests.
  2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet (30 m) or less of wall length but no fewer than two tests.
  3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet (46 m) or less of trench length but no fewer than two tests.
- F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

### 3.20 PROTECTION

- A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

- B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.
  - 1. Scarify or remove and replace soil material to depth as directed by Architect; reshape and recompact.
- C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

### 3.21 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Transport surplus satisfactory soil to designated storage areas on Owner's property. Stockpile or spread soil as directed by Architect.
  - 1. Remove waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

SECTION 31 23 19 - DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."
- B. Form 817 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction Form 817-2019 July its latest edition and any supplemental specifications.
- C. Report on Geotechnical Engineering Investigation, dated, January 21, 2019, prepared by GNCB Consulting Engineers, P.C.
- D. Summary of Groundwater wells, by GNCB Consulting Engineers, P.C. available upon request.
- E. Particle Size Analysis and Permeability Results, by GNCB Consulting Engineers, P.C. available upon request.

1.2 SUMMARY

- A. This Section includes construction dewatering.
- B. Related Sections include the following:
  - 1. Division 1, Section "Temporary Facilities and Controls".
  - 2. Section 017419 "Construction and Demolition Waste Management and Disposal".
  - 3. Section 018113 "Sustainable Design Requirements".
  - 4. Section 018119 "Construction Indoor Air Quality Requirements".
  - 5. Section 312333 "Trenching and Backfilling".
  - 6. Section 315000 "Excavation Support and Protection."
  - 7. Section 312000 "Earth Moving".
- C. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

### 1.3 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High-Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

### 1.4 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain a dewatering system of sufficient scope, size, and capacity to control groundwater flow into excavations and permit construction to proceed on dry, stable sub-grades.
1. Maintain dewatering operations to ensure erosion control, the stability of excavations and constructed slopes, that excavation does not flood, and that damage to sub-grades and permanent structures is prevented.
  2. Prevent surface water from entering excavations by grading, dikes, or other means.
  3. Accomplish dewatering without damaging existing buildings adjacent to the excavation.
  4. Remove the dewatering system if no longer needed.

### 1.5 ACTION SUBMITTALS

- A. Shop Drawings: For dewatering system, prepared and certified by or under the supervision of a qualified professional engineer licensed in the State of Connecticut.
1. Include plans, elevations, sections, and details.
  2. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, and discharge lines; and means of discharge, control of sediment, and disposal of water.
  3. Include layouts of piezometers and flow-measuring devices for monitoring the performance of the dewatering system.
  4. Include written plan for dewatering operations including sequence of a well and well-point placement coordinated with excavation shoring and bracings and control procedures to be adopted if dewatering problems arise.
- B. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the



Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, land surveyor, and professional engineer.
- B. Field quality-control reports.
- C. Existing Conditions: Using photographs or video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by dewatering operations. Submit before Work begins.
- D. Record Drawings: Identify locations and depths of capped wells and well points and other abandoned-in-place dewatering equipment.

#### 1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer that has specialized in the design of dewatering systems and dewatering work.
- B. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.
- C. Pre-installation Conference: Conduct conference at Project site to comply with requirements in Division 1 Section "Project Management and Coordination."

#### 1.8 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted in writing by Construction Manager and /or Architect and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A Geotechnical Report has been prepared for this project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. Owner, Architect, and Site Engineer of Record will not be responsible for interpretations or conclusions are drawn from this data.
  - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
  - 2. The Geotechnical Report is included elsewhere in the Project Manual.

- C. Survey adjacent structures and improvements, employing a qualified land surveyor, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.
  - 1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Construction Manager and /or Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of groundwater and permit excavation and construction to proceed on dry, stable subgrades.
  - 1. Design dewatering system, including comprehensive engineering analysis, by a qualified professional engineer licensed in the State of Connecticut.
  - 2. Continuously monitor and maintain dewatering operations to ensure erosion control, the stability of excavations and constructed slopes, prevention of flooding in excavation, and prevention of damage to subgrades and permanent structures.
  - 3. Prevent surface water from entering excavations by grading, dikes, or other means.
  - 4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to the excavation.
  - 5. Remove the dewatering system when no longer required for construction.
- B. Regulatory Requirements: Comply with governing CT DEEP and EPA notification regulations before beginning dewatering. Comply with water- and debris-disposal regulations of authorities having jurisdiction.

### 2.2 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
  - 1. Prevent surface water and subsurface or groundwater from entering excavations, from ponding on prepared sub-grades, and from flooding site and surrounding area.
  - 2. Protect sub-grades and foundation soils from softening and damage by rain or water accumulation.
- B. Install the dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Provide temporary grading to facilitate dewatering and control of surface water.
- D. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section 312513 "Erosion and Sedimentation Control," during dewatering operations.

### 3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  - 1. Space well points or wells at intervals required to provide sufficient dewatering.
  - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place the dewatering system into operation to lower water to specified levels before excavating below the groundwater level.
- C. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

- D. Before excavating below groundwater level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed, or until dewatering is no longer required.
- E. Provide an adequate system to lower and control groundwater to permit excavation, construction of structures, and placement of fill materials on dry sub-grades. Install sufficient dewatering equipment to drain water-bearing strata above and below the bottom of foundations, drains, sewers, and other excavations.
  - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, sub-grade softening, and slope instability.
- F. Reduce hydrostatic head in water-bearing strata below sub-grade elevations of foundations, drains, sewers, and other excavations.
  - 1. Maintain a piezometric water level a minimum of 24 inches below the surface of excavation.
- G. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- H. Provide standby equipment on-site, installed, and available for immediate operation, to maintain dewatering on a continuous basis if any part of the system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of the dewatering system, restore damaged structures and foundation soils at no additional expense to the Owner.
  - 1. Remove the dewatering system from the Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.
- I. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

### 3.3 OBSERVATION WELLS

- A. Provide, take measurements, and maintain at least the minimum number of observation wells or piezometers indicated and additional observation wells as may be required by authorities having jurisdiction.
- B. Observe and record daily elevation of groundwater and piezometric water levels in observation wells.

- C. Repair or replace, within 24 hours, observation wells that become inactive, damaged, or destroyed. Suspend construction activities in areas where observation wells are not functioning properly until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
  - 1. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.

### 3.4 FIELD QUALITY CONTROL

- A. Observation Wells: Provide observation wells or piezometers, take measurements, and maintain at least the minimum number indicated; additional observation wells may be required by authorities having jurisdiction.
  - 1. Observe and record daily elevation of groundwater and piezometric water levels in observation wells.
  - 2. Repair or replace, within 24 hours, observation wells that become inactive, damaged or destroyed. In areas where observation wells are not functioning properly, suspend construction activities until reliable observations can be made. Add or remove water from observation-well risers to demonstrate that observation wells are functioning properly.
  - 3. Fill observation wells, remove piezometers, and fill holes when dewatering is completed.
- B. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.
- C. Provide continual observation to ensure that subsurface soils are not being removed by the dewatering operation.
- D. Prepare reports of observations.

### 3.5 PROTECTION

- A. Protect and maintain the dewatering system during dewatering operations.
- B. Promptly repair damages to adjacent facilities caused by dewatering.

END OF SECTION 312319

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SECTION 334000 – TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Furnish all labor, materials, equipment, and incidentals required and perform all trenching for pipelines, structures, and appurtenances, including drainage, filling, backfilling, compaction, disposal of surplus material and restoration of trench surfaces and easements.
- B. Excavation shall extend to the width and depth shown on the Drawings or as specified herein and shall provide a suitable room for installing pipe, structures, and appurtenances.
- C. Furnish and place all sheeting, bracing, and supports and remove from the excavation all materials which the Architect and/or Construction Project Manager may deem unsuitable for backfilling. The bottom of the excavation shall be firm, dry, and in all respects, acceptable. As specified on the Drawings, place geotextile filter fabric, if required, followed by screened gravel for pipe bedding, or gravel refill for excavation below grade, directly on the bottom of the trench immediately after excavation has reached the proper depth and before the bottom of the trench has become softened or disturbed by any cause whatever. The length of the open trench shall be related closely to the rate of pipe laying. All excavations shall be made in open trenches.
- D. All excavation, trenching, and related sheeting, bracing, etc, shall comply with the requirements of OSHA excavation safety standards (29 CFR Part 1926.650 Subpart P) and State requirements. Where a conflict between OSHA and State regulations exists, the more stringent requirements shall apply.
- E. Wherever the requirement for 95 percent compaction is referred to herein, it shall mean "at least 95 percent of maximum density as determined by ASTM D1557, Method D".
- F. Prior to the start of work, submit the proposed method of backfilling and compaction to the Architect and/or Construction Project Manager for review.
- G. The Contractor shall take all necessary precautions to prevent subgrade disturbance and any excavation and refilling resulting from disturbance. In addition, the Contractor shall take all precautions to prevent excavated soils from becoming excessively wet due to exposure to inclement weather.

- H. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. State of Connecticut Department of Transportation “The Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, as amended and merged with the current July 2019 supplemental specifications.
- C. Form 817, July 2019 supplemental Section M.01 is attached at the end of this specification.

#### 1.3 RELATED SECTIONS

- A. Section 312000 -“Earthmoving” for Excavation, Detectable Warning Tape, and Backfill.
- B. Section 315000 -“Excavation Support and Protection” for Shoring, Sheeting, and Bracing.
- C. Section 331000 -“Exterior Water Utilities” for pipe bedding materials of water utility trenches.
- D. Section 333000 -“Exterior Sanitary Sewer Utilities” for pipe bedding materials of sanitary sewer utility trenches.
- E. Section 334000 -“Storm Sewer Utilities” for pipe bedding materials and geotextile fabric of storm sewer utility trenches.
- F. Section 017419 – “Construction and Demolition Waste Management and Disposal”.
- G. Section 018113 – “Sustainable Design Requirements”.
- H. Section 018119 – “Construction Indoor Air Quality Requirements”.

#### 1.4 ABBREVIATIONS

- A. HDPE: High-density polyethylene
- B. PE: Polyethylene
- C. PVC: Polyvinyl chloride plastic



1.5 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High-Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

1.6 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
1. Notify Architect and/or Construction Project Manager not less than two days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Architect and/or Construction Project Manager's written permission.

1.7 SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- B. Product Data: Complete mechanical/sieve analysis classification according to Form 817 and ASTM D 2487 for each type of material used for trenching and backfill.
- C. Warning Tape manufacturer data for each utility.
- D. Geotextile manufacturer data.
- E. Qualification Data: For qualified testing agency.
- F. Material Test Reports: From an approved qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:

1. Report of actual unconfined compressive strength and/or results of bearing tests of each stratum tested.
2. Test sampling shall conform to the requirements of ASTM D-75, and ASTM D-3665.

**PART 2 - MATERIALS AND PRODUCTS**

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.
- B. Crushed Stone: Clean, sound material free of debris, waste, frozen materials and organic material conforming to Form 817, including July 2019 supplemental, Article M.01, size as indicated on Drawings. Form 817, July 2019 supplemental Section M.01.

**M.01.01—General:**

Each source of aggregate must be qualified for use by the Engineer as indicated in 1.06.01.

Material from a qualified source is still subject to Project-level testing and may be subject to rejection as indicated in 1.06.04.

Aggregates must not have expansive or reactive properties. Aggregates reclaimed from pavements or structures may only be used where specifically allowed in the specifications.

Aggregate stockpiles must be located on smooth, hard, sloped/well-drained areas. Each source and gradation of aggregate must have an individual stockpile or bin. Stockpiles must be managed to minimize segregation and contamination with foreign materials.

**M.01.02—Coarse Aggregates:**

Coarse aggregate must be uniform in consistency and only contain clean, hard, tough, durable fragments meeting the criteria in Table M.01.02-1.

**TABLE M.01.02-1: Coarse Aggregate Criteria by Pit/Quarry Source**

Item	Title	AASHTO Test Methods	Criteria
1	Material Passing No. 200 Sieve	T 11	1% maximum
2	Loss on Abrasion	T 96	40% maximum
3	Soundness by Magnesium Sulfate	T 104	10% maximum @ 5 cycles

Standard sizes of coarse aggregate for applications other than bituminous concrete must meet the gradation requirements listed in Table M.01.02-2 as determined by AASHTO T27.

**TABLE M.01.02-2: Gradation of Standard Sizes of Coarse Aggregate**

Square Mesh Sieves	Percent Passing by Weight					
	No. 3	No. 4	No. 6	No. 67	No. 8	No. 9
2 1/2 inches	100					
2 inches	90-100	100				
1 1/2 inches	35-70	90-100				
1 inch	0-15	20-55	100	100		
3/4 inch		0-15	90-100	90-100		
1/2 inch	0-5		20-55		100	
3/8 inch		0-5	0-15	20-55	85-100	100
No. 4			0-5	0-10	10-30	85-100
No. 8				0-5	0-10	10-40
No. 16					0-5	0-10
No. 50						0-5

**M.01.03—Fine Aggregates:**

Fine aggregate must consist of clean, hard, durable, tough, uncoated particles free from lumps, meeting the requirements listed in Table M.01.03-1.

**TABLE M.01.03-1: Fine Aggregate Requirements**

Item	Property	AASHTO Test	Criteria
1	Grading		
	Portland Cement Concrete	T 11 T 27	3% maximum passing No. 200 sieve Table M.01.04-1
	Bituminous Concrete	T 27	100% passing 3/8 inch, 95% passing No. 4 minimum
2	Absorption	T 84	3% maximum
3	Plasticity Limits	T 90	0 or not detectable
4	L.A. Abrasion	T 96	50% maximum (fine aggregate particle size $\geq$ No. 8)
5	Soundness by Magnesium Sulfate	T 104	15% maximum @ 5 cycles for PCC 20% maximum @ 5 cycles for Bit. Conc.
6	Clay Lumps and Friable Particles	T 112	3% maximum

7	Deleterious Material - organic or inorganic calcite, hematite, pyrrhotite, shale, clay, coal-lignite, shells, loam, mica, clinkers, or other organic matter (wood, etc.)	As determined by the Engineer	Must not contain more than 3% by mass of any individual listed constituent and not more than 5% by mass in total of all listed constituents.
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- C. Bedding Course: Naturally or an artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand;
- D. Storm and Sanitary sewer pipe bedding material: CT DOT 817, including July 2019 supplemental, M.08.03. If groundwater encountered use ¾” clean crushed stone conforming to CT DOT FORM 817, including July 2019 supplemental, M.01.02-2 #6. Form 817, July 2019 supplemental Section M.01. See above.
- E. Water pipes bedding as defined on drawings and details.
- F. Conduit and pipes that are 4-inch diameter and smaller bedding: use sand material CT DOT 817, including July 2019 supplemental, M.01.03-1 for Portland Cement Concrete criteria. Form 817, July 2019 supplemental Section M.01. See above.
- G. Initial Backfill for storm pipes as defined on the drawings and details. Class 1 or 2 conforming to ASTM D2321. Classes of Embedment and Backfill Materials table below:

ASTM D2321 <sup>(A)</sup> Class	ASTM D2321 <sup>(A)</sup> Description	Notation	ASTM D2487 Description	AASHTO M43 Notation	AASHTO M145 Notation	ASTM D2321 <sup>(A)</sup>							
						Percentage Passing Sieve Sizes				Atterberg Limits		Coefficients	
						1 ½ in. (40mm)	3/8” (9.5mm)	No. 4 (4.75mm)	No. 200 (0.075mm)	LL	PI	Cu	Cc
(B)	Crushed rock, angular <sup>C</sup>	N/A	Angular crushed stone or rock, crushed gravel, crushed slag; large voids with little or no fines	5, 56, 57 <sup>(D)</sup> , 6, 67 <sup>(B)</sup>	N/A	100%	≤25%	≤15%	<12%	Non Plastic		N/A	
II	Clean, coarse-grained soils	GW	Well-graded gravel, gravel-sand mixtures; little or no fines	5, 6	A1, A3	100%	-	<50% of "Coarse Fraction"	<5%	Non Plastic	>4	1 to 3	
		GP	Poorly-graded gravels, gravel-sand mixtures; little or no fines	56, 57, 67							<4	<1 or >3	
		SW	Well-graded sands, gravelly sands; little or no fines								>6	1 to 3	
		SP <sup>F</sup>	Poorly-graded sands, gravelly sands; little or no fines								<6	<1 or >3	
	Coarse-Grained Soils, borderline clean to w/fines	GW-GC, SP-SM	Sands and gravels which are borderline between clean and with fines	N/A		100%	-	Varies	5% to 12%	Non Plastic	Same as for GW, GP, SW and SP		

Notes:

- a. Refer to ASTM D2321 for more complete soil descriptions.

- b. Class I materials allow for a broader range of fines than previous versions of D2321. When specifying class I material for infiltration systems, the engineering shall include a requirement for an acceptable level of fines.
  - c. All particle faces shall be fractured.
  - d. Assumes less than 25 % passes the 3/8" sieve.
- H. Flowable fill to be used as backfill where identified on the drawings. The flowable fill mix should be designed to meet all strength and flowability requirements. A suggested strength ranges between 50 psi and 100 psi the 28-day strength; mixes that have 28-day compressive strengths greater than 100 psi should be avoided due to increased difficulty in future excavation if needed. The flowable fill should be able to flow into all voids between the pipe and the trench walls. The mix design should be laboratory tested prior to installation ensure that the proper results are obtained during field batching. The field mix may also require monitoring and adjustments to maintain the proper mix and properties. These variations in the field mix can be due to many factors including water content, temperature and humidity during placement.
- 1. Controlled Low-Strength Material: Self-compacting, low-density, flowable concrete material produced from the following:
    - a. Portland Cement: ASTM C 150, Type I or Type II, meeting State of Connecticut DOT standards for use as mix-water for cast-in-place concrete.
    - b. Fly Ash: ASTM C 618, Class C or F.
    - c. Normal-Weight Aggregate: ASTM C 33, 3/8-inch nominal maximum aggregate size.
    - d. Foaming Agent: ASTM C 869.
    - e. Water: ASTM C 94.
    - f. Air-Entraining Admixture: ASTM C 260
  - 2. Produce low-density, controlled low-strength material with the following physical properties:
    - a. As-Cast Unit Weight: 30 to 36 lb./cu. ft. at point of placement, when tested according to ASTM C 138.
    - b. Compressive Strength: 50psi to 100 psi, when tested according to ASTM C 495.
      - 1) Produce conventional-weight, controlled low-strength material with 50-psi to 100-psi compressive strength when tested according to ASTM C 495.
- I. Sand: Shall comply with the Standard Specifications M.03.01.2. sand material CT DOT 817, including July 2019 supplemental, M.01.03-1 for Portland Cement Concrete criteria. Form 817, July 2019 supplemental Section M.01. See below.

**M.01.04—Portland Cement Concrete (PCC) Aggregates:**

In addition to the requirements in M.01.01 through M.01.03, the aggregates used in Portland Cement Concrete must meet the following:

All Aggregates: Coarse and Fine aggregates must originate from the aggregate producers and locations included on the Department's Qualified Materials List (QML). The list is available on the Department website. The criteria for inclusion in the QML are stated within the list.

Coarse Aggregate: Coarse aggregate of a size retained on a 1 inch square opening sieve must not contain more than 8% of flat and elongated pieces when tested in accordance with ASTM D4791 at a 1:5 ratio.

Reclaimed concrete aggregates must consist of clean, durable fragments of uniform quality. Materials must be from crushing or otherwise processing of concrete structures or portions thereof. Prior to demolition or removal, concrete structures must not exhibit signs of material degradation and be inspected by the Engineer. Reclaimed aggregate must be tested separately to confirm compliance with all requirements prior to blending with virgin aggregate.

Reclaimed coarse aggregate must not contain chlorides in excess of 0.5 lb./c.y. Chloride content must be determined in accordance with AASHTO T 260, Procedure A. Regardless of chloride content, reclaimed aggregates must not be used in concrete for prestressed concrete members.

Fine Aggregate: Manufactured sand must be produced from washed stone screenings; stone screenings or gravel; or combinations thereof, after mechanical screening or with a process approved by the Engineer.

The fineness modulus of fine aggregate from a source must not vary more than 0.20 from the base fineness modulus of that source.

The fine aggregate must not produce a color darker than Gardner Color Standard No. 11 in accordance with AASHTO T 21.

Fine aggregates that fail to meet soundness requirements as specified in Table M.01.03-1, but meet all other requirements, may be used with the approval of the Engineer on a case-by-case basis. Typically concrete composing any surface subject to polishing or abrasion (i.e., wheel traffic or running water) will not be allowed to contain such material.

Gradation of each size aggregate must be within the ranges listed in Table M.01.04-1 as determined by AASHTO T 27.

**TABLE M.01.04-1: Fine Aggregate Gradations**

Sieve Size	3/8 inch	No. 4	No. 8	No. 16	No. 30	No. 50	No. 100	
% passing	100	95-100	80-100	50-85	25-60	10-30	2-10	

J. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

K. In conformance with Section 16- 345 through 16-359 of the Regulations of the PURA, the Contractor is responsible for notifying "Call Before You Dig" prior to commencing any excavation, including milling, reclamation or trenching; and the Contractor shall install a warning tape located a minimum of 12 inches above all conduits, wires, cables, utility pipes, drainage pipes, underdrains, or other facility, unless the excavation's depth, other underground facilities, or other engineering considerations make this minimum separation unfeasible. The warning tape shall be of durable impervious material, designed to withstand extended underground exposure without material deterioration or fading of color. The tape shall be of the

color assigned to the type of facility for surface markings and shall be durably imprinted with an appropriate warning message. The tape shall also comply with the specific requirements of the utility that owns the facility.

- L. All tapes, unless otherwise directed by the specific utility, shall be detectable to a depth of at least 3 feet with a commercial radio-type metal locator.
  - 1. Assigned colors are:
    - a. Green - Storm and sanitary sewers and drainage systems, including force mains and other non-hazardous materials
    - b. Blue - Water
    - c. Orange - Communication lines or cables, including, but not limited to, those used in, or in connection with, telephone, telegraph, fire signals, cable television, civil defense, data systems, electronic controls and other instrumentation
    - d. Red - Electrical power lines, electrical power conduits and other electrical power facilities, traffic signals and appurtenances and illumination facilities
    - e. Yellow - Gas, oil petroleum products, steam, compressed air, compressed gases and all other hazardous material except water
    - f. Brown - Other
    - g. Purple - Radioactive materials
- M. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, 3-4 inches wide and 4 mils thick, continuously inscribed with a description of the utility with metallic core encased in a protective jacket for corrosion protection.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

### 3.2 IDENTIFICATION

- A. Arrange for installing appropriately colored warning detectable tapes directly over piping and at outside edges of underground structures.
  - 1. Use detectable warning tape over ferrous piping.
  - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.



### 3.3 UNSUITABLE MATERIALS

- A. Unsuitable materials are herein defined as organic material, peat, organic silt, or combinations thereof, all having unsuitable in-situ bearing properties and all materials of whatever description which are too loose or saturated for use as backfill to provide a satisfactory bearing.
- B. If unsuitable material is encountered at the depths indicated on the drawings for the bottom limit of excavation that is intended for fill and backfill include unsatisfactory soil materials and/or rock, the Contractor shall replace the quantity required with satisfactory soil materials at the Contractor's expense.
- C. Remove rock to the lines and grades indicated to permit installation of permanent construction without exceeding the following dimensions:
  - 1. 6 inches beneath pipe/conduit in trenches, and the greater of 24 inches wider than pipe/conduit or 42 inches wide.
- D. The Contractor shall satisfactorily excavate and remove all unsuitable material to lines, grades and limits indicated on the drawings or as directed in writing by the Architect and/or Construction Project Manager and shall satisfactorily dispose of such material off the site.
- E. All resulting below-grade excavations shall be refilled with compacted bank-run gravel refill.

### 3.4 TRENCH EXCAVATION

- A. Trench excavation shall include material of every description and of whatever substance encountered, except rock and boulders. Pavement shall be saw cut along straight lines before excavating.
- B. Strip and stockpile topsoil from grassed areas crossed by trenches. At the Contractor's option, topsoil may be otherwise disposed of and replaced, when required, with approved topsoil of equal quality.
- C. While excavating and backfilling is in progress, traffic shall be maintained, and all utilities and other property protected as provided in the General Conditions and General Requirements.
- D. Trenches shall be excavated to the depth indicated on the Drawings and in widths sufficient for laying the pipe, bracing and for pumping facilities. The bottom of the excavations shall be firm and dry and in all respects acceptable to the Architect and/or Construction Project Manager. The trench width shall be a practical minimum.



- E. Excavate trenches to uniform widths to provide the following clearance on each side of the pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than the top of the pipe or conduit unless otherwise indicated.
1. Clearance: 12 inches each side of pipe or conduit, or as indicated on Drawings.
- F. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Excavate trenches 4 inches deeper than the bottom of pipe and conduit elevations to allow for bedding course. Hand-excavate deeper for bells of pipe. Shape sub-grade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along the trench sub-grade.
1. For pipes and conduit less than 6 inches in nominal diameter, hand-excavate trench bottoms and support pipe and conduit on an undisturbed sub-grade.
  2. For pipes and conduit 6 inches or larger in nominal diameter, shape the bottom of the trench to support the bottom 90 degrees of pipe or conduit circumference. Fill depressions with tamped sand backfill.
  3. For flat-bottomed, multiple-duct conduit units, hand-excavate trench bottoms and support conduit on an undisturbed sub-grade.
  4. Excavate trenches 12 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
- G. Trenches in Tree and Plant Protection Zones:
1. Hand-excavate to indicated lines, cross-sections, elevations, and sub-grades. Use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.
  2. Do not cut main lateral roots or taproots; cut only smaller roots that interfere with the installation of utilities.
  3. Cut and protect roots according to requirements on the drawings.
- H. Excavation and dewatering shall be accomplished by methods that preserve the undisturbed state of subgrade soils. The trench may be excavated by machinery to, or just below the designated subgrade, provided that material remaining in the bottom of the trench is no more than slightly disturbed. Subgrade soils that become soft, loose, “quick”, or otherwise unsatisfactory as a result of inadequate excavation, dewatering or other construction methods shall be removed and replaced by screened gravel fill as required by the Architect and/or Construction Project Manager at the Contractor’s expense.
- I. Clay and silty soils are particularly susceptible to disturbance due to construction operations. When excavation is to end in such soils, use a smooth edge bucket to excavate the last 1-ft of depth.

- J. Where pipe is to be laid in screened gravel bedding, the trench may be excavated by machinery to the normal depth of the pipe provided that the material remaining in the bottom of the trench is no more than slightly disturbed.
- K. Where pipe is to be laid directly on the trench bottom, final excavation at the bottom of the trench shall be performed manually, providing a flat bottom true to grade upon undisturbed material. Bell holes shall be made as required.
- L. Where existing subsurface utilities or other facilities adjacent to or crossing through the excavation require temporary support or protection, such temporary support or protection shall be satisfactorily provided by the Contractor, at no additional expense to the Owner. All necessary measures shall be taken by the Contractor to prevent lateral movement or settlement of existing facilities or of work in progress.
- M. Steel plate crossings may be required in place of plank crossings to cover excavations, which are temporarily not in use by the Contractor. These excavations shall be bridges with at least 1-inch thick steel plates that conform to ASTM A36 and weigh not less than 1,000 pounds each.
- N. The plates shall extend a minimum of two (2) feet beyond all edges of the excavation. Fastening shall be a removable spike, with flush heads, or other suitable means to prevent vibratory movement. The difference in elevation between the top of the plate and the street surface shall be smoothed over or ramped with bituminous concrete.
- O. The Contractor shall strictly adhere to all Federal, State and local regulations regarding safety during the performance of this work, including Occupational Safety and Health Administration (OSHA) Construction Standards for Excavations, 29 CFR part 1926, latest revision.

### 3.5 TRENCH BACKFILL

- A. Place backfill on sub-grades free of mud, frost, snow, or ice.
- B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Trenches under Footings: Backfill trenches excavated under footings and within 18 inches of the bottom of footings with satisfactory soil; fill with concrete to the elevation of the bottom of footings. Concrete is specified in Section 033000 "Cast-in-Place Concrete" and/or Section 033053 "Miscellaneous Cast-in-Place Concrete."
- D. Trenches under Roadways: Backfill as specified on Drawings.

- E. Backfill voids with satisfactory soil while removing shoring and bracing.
- F. Place and compact initial backfill as specified on the Drawings, free of particles larger than 1 inch in any dimension, to a height of 12 inches over the pipe or conduit.
- G. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utility testing.
- H. Controlled Low-Strength Material/ Flowable fill: Place the initial backfill of controlled low-strength material to a height of 12 inches over the pipe or conduit. Coordinate backfilling with utility testing.
- I. Place and compact final backfill of satisfactory soil to final sub-grade elevation.
- J. Controlled Low-Strength Material/ Flowable fill: Place the final backfill of controlled low-strength material to final sub-grade elevation.
- K. Install warning tape directly above utilities as shown on the drawings and details or 12 inches below finished grade, except 6 inches below sub-grade under pavements and slabs.
- L. Uniformly moisten or aerate sub-grade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to the specified dry unit weight.
- M. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- N. Place backfill and fill soil materials evenly to required elevations, and uniformly along the full length of each trench.
- O. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698 or ASTM D 1557:
  - 1. For utility trenches and areas extending 5 feet around, compact each layer of initial and final backfill soil material at 85 percent.

3.6 FIELD QUALITY CONTROL

- A. Testing Agency: The owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing and inspection.
- B. The testing agency will test the compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
  - 1. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for every 150 feet or less of trench length, but no fewer than two (2) tests.
- C. When testing agency reports that backfills have not achieved the degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; re-compact and retest until specified compaction is obtained.

3.7 DISPOSAL OF MATERIALS

- A. No excavated material shall be stacked on the trench bank or along the roadways. Inconvenience to traffic and abutters shall be avoided as much as possible. Excavated material shall be segregated for use in backfilling as specified below.
- B. Where allowed, excavated material suitable for backfilling shall be hauled and temporarily stored and re-handled or use in the backfilling process. All surplus materials shall be disposed of in approved designated areas.

END OF SECTION 312333

SECTION 312500 – EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.1 SUMMARY

- A. This work shall consist of temporary measures needed to control erosion and water pollution. These temporary measures shall include, but not be limited to, silt fence/haybales berms, silt socks, erosion blankets/mats, netting, gravel, mulches, grasses, and other erosion control devices or methods. These temporary measures shall be installed at the locations where needed to control erosion and water pollution during the construction of the Project, and as directed by the Construction Manager or Engineer or Authorities having jurisdiction, and as shown on the drawings.
- B. The Erosion Control Plan presented in the drawings serves as a minimum for the requirements of erosion control during construction. The Contractor has the ultimate responsibility for providing adequate erosion control and water quality throughout the duration of the Project. Therefore, if the provided plan is not working sufficiently to protect the project areas, then the Contractor shall provide additional measures as required to obtain the required protection. The Contractor shall include in the bid price for erosion control a minimum of all items shown on the Erosion Control Plan and any additional items that may be needed to control erosion and water pollution.
- C. Use 100% biodegradable plant-based products and materials such as jute (vegetable fiber), sisal (stiff agave fiber) or coir (coconut husk fiber) for sedimentation and erosion control within the wetlands and watercourses to be protective of wildlife species such as amphibians, reptiles, and birds in the project area. All erosion controls used for the Project shall be removed as soon as soils have been stabilized to avoid impending amphibian and reptile movement between wetlands/watercourses and uplands.
- D. Mulches (chemical or organic) cannot be applied within wetlands or immediately adjacent to wetlands and watercourses to mitigate water quality impacts.
- E. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The Project is subject to General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities. Part of the General Permit, Stormwater

Pollution Control Plan (SWPCP) is prepared and approved by CT DEEP for the Contractor to use.

- C. CT DEEP license for Flood Management Certification Approval and General Permit for Water Resource Construction Activities- Approval conditions.
- D. State of Connecticut Department of Transportation "The Standard Specifications for Roads, Bridges and Incidental Construction," Form 817, as amended and merged with the current July 2019 supplemental specifications.
- E. The Connecticut Council on Soil and Water Conservation in Cooperation with the Connecticut Department of Environmental Protection "2002 Connecticut Guidelines for Soil Erosion and Sediment Control", as amended and merged with the current errata.

### 1.3 RELATED SECTIONS

- A. Section 015000 - "Temporary Facilities and Controls" for temporary utilities and support facilities.
- B. Section 312319 - "Dewatering".
- C. Section 311100 - "Site Clearing".
- D. Section 017419 – "Construction and Demolition Waste Management and Disposal".
- E. Section 018113 – "Sustainable Design Requirements".
- F. Section 018119 – "Construction Indoor Air Quality Requirements".

### 1.4 SUSTAINABILITY REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.
- B. Prevent the loss of soil during construction by stormwater runoff and/or wind erosion, including protecting topsoil by stockpiling for reuse.
- C. Prevent sedimentation of storm sewer or receiving streams.

- D. Prevent polluting the air with dust and particulate matter.

#### 1.5 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

#### 1.6 SUBMITTALS

- A. Product data for materials proposed for use.
- B. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

#### 1.7 QUALITY ASSURANCE

- A. Preconstruction Conference: Conduct conference at Project site to comply with requirements in Division 01, Section "Project Coordination." Coordinate with project sediment and erosion control requirements.
- B. The Project is subject to General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities. Part of the General Permit, Stormwater Pollution Control Plan (SWPCP) is prepared and approved by CT DEEP for the Contractor to use.
- C. The Project consists of two (2) phases. Contractor to install, repair, and maintain the erosion and sedimentation devices as defined by the SWPCP or as directed by the CT DEEP, or Erosion, and Sedimentation Inspecting Engineer or Qualify Professional.
- D. Topsoil Stripping and Stockpiling Program: Prepare a written program to systematically demonstrate the ability of personnel to properly follow procedures and handle materials and equipment during the Work. Include dimensioned diagrams for placement and protection of stockpiles.
- E. All work shall comply with all codes, rules, regulations, laws, and ordinances for the State of Connecticut, and all other authorities having jurisdiction.

#### 1.8 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth-moving operations.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction.
  - 2. Provide alternate routes around closed or obstructed traffic ways if required by the Owner or authorities having jurisdiction.

1.9 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2–PRODUCTS of Section 018113 – Sustainable Design Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Soil erosion and sedimentation controls shall consist of temporary erosion control measures as shown on the Plans, or as ordered by the Construction Manager, during the life of the contract to control water pollution, soil erosion, and siltation through the use of common erosion control methods including hay bales and siltation fences, silt booms, silt sacks, and construction entrances / anti-tracking pads. The temporary erosion control measures contained herein and as shown on the contract drawings shall be installed and coordinated to assure economical, effective, and continuous erosion control throughout the construction period. The Contractor shall install and maintain the devices during construction. The maintenance shall be performed twice a week or after storm events of 0.5 inches or greater. Contractor shall have a log of the erosion control inspections

1. SILTATION FENCE:

Synthetic filter fabric should be a pervious sheet of polypropylene, nylon, polyester, ethylene or similar filaments and shall be certified by the manufacturer or supplier as conforming to the requirements in Table 1 below.

TABLE 1 – GEOTEXTILE SILT FENCING MINIMUM REQUIREMENTS

Physical Property	Test Method	Minimum Requirement
Grab tensile strength (lbs.)	ASTM D4632	124 lbs.
Grab Elongation	ASTM D4632	15 X 20%
Trapezoidal tear	ASTM D4533	65 lbs.
UV Resistance at 500 hrs	ASTM D4355	80%
Apparent opening size (AOS)	ASTM D4751	30 US Std. Sieve
Water Flow rate	ASTM D4491	10 gpm/ft <sup>2</sup>
Permittivity	ASTM D4491	0.1 sec <sup>-1</sup>
Roll sizes		3.0 ft. x 1500 ft. 3.5 ft. x 330 ft.



The geotextile shall be non-rotting, acid and alkali resistant and have sufficient strength and permeability for the purpose intended, including handling and backfill operations. Filaments in the geotextile shall be resistant to absorption. The filament network must be dimensionally stable and resistant to delamination. The geotextile shall be free of any chemical treatment or coating that will reduce its permeability. The geotextile shall also be free of any flaws or defects which will alter its physical properties. Torn or punctured geotextiles shall not be used. The geotextile shall be on the Connecticut Department of Transportation's "Qualified Product List".

The geotextile silt fence must be staked, and the geotextile entrenched to a minimum depth of six inches below the existing surface. The supporting posts shall be at least 42 inches long made of either 1.5-inch square hardwood stakes or steel posts with projections for fastening the geotextile and possessing a minimum strength of 0.5 pounds per linear foot. The support posts shall be driven to a depth of at least 12 inches into the existing ground and never installed more than 10 feet apart

The siltation fence shall be stored in a manner that will protect it from the elements. If stored outdoors, it shall be elevated and protected with a waterproof cover. Both the geotextile and threads associated with the fence shall be resistant to chemical attack, mildew, and rot. Each roll of fabric shall be labeled or tagged to provide product identification as well as inventory and quality control purposes.

2. HAY BALES:

The hay bales shall be made of hay or straw with 40 pounds minimum weight and 120 pounds maximum weight held together by twine or wire.

The stakes for anchoring hay bales shall be a minimum of 36 inches long and made of either hardwood with dimensions of at least 1.5 inches square or steel posts with a minimum weight of 0.5 pounds per linear foot.

The hay bales shall be entrenched to a minimum depth of 4 inches below the existing surface. Place the hay bales in a single row in the trench, lengthwise, with ends of adjacent bales tightly abutting on another and the binding oriented around the sides rather than along the tops and bottoms of the bale in order to prevent premature rotting of the bindings.

Anchor each bale with at least 2 stakes, driving the first stake in each bale toward the previously laid bale to force the bales together. Stakes must be driven a minimum of 18 inches into the ground. Fill any gaps between the bales with hay or straw to prevent water from escaping between the bales.

Backfill the bales with the excavated trench material to a minimum depth of 4 inches on the uphill side of the bales. Tamp down by hand or machine and

compact the soil. Cover the disturbed area immediately uphill from the hay bale barrier with loose hay or straw to increase the efficiency of the barrier.

Hay bales shall be stored in a manner that will protect them from the elements. If stored outdoors, they shall be elevated and protected with a waterproof cover.

3. SILTATION FENCE/HAYBALES BARRIER (SF/HB)

A temporary sediment barrier composed of permeable geotextile filter fabric attached to supporting posts and hay or straw bales with hardwood or steel anchoring posts. Installation of the barrier is a composition of the geotextile filter fabric and hay bales placement into one unit. The hay barrier can pass water flow but retains water long enough for sediments to deposit. Backfill the barrier with size 1-1/4" crushed stone (CT DOT FORM 817, including July 2019 supplemental, M.01. aggregate #4) on the uphill side of the barrier. This way installed barrier resists the flow of water and prevents the transport of sediment under, around, or over the barrier.

The barrier will be placed in areas shown on the sedimentation and erosion control plans, during all of the phases of the Project.

4. SILTATION FENCE/ HAYBALE/ STONE/ SILT FENCE/ HAYBALE BARRIER (SF/HB/S/SF/HB):

A temporary sediment barrier composed of a permeable geotextile filter fabric attached to supporting posts, haybales with stakes, size 1-1/4" (CT DOT FORM 817, including July 2019 supplemental, M.01. aggregate #4) crushed stone, permeable geotextile filter fabric attached to supporting posts, and haybales with stakes. Materials in the barrier can pass water flow but retain water long enough for sediments to deposit. The detail for installation is shown on the sheet CX-502. The barrier is to be installed around the existing pond and wetlands, at the toe of the proposed slope. It will allow surface water to slowly pass through and prevents the transport of sediments to environmentally sensitive areas.

The barrier will be installed at the beginning of the construction and remains through all phasing until all areas upslope are stable and vegetation has been established.

5. SILT BOOM:

Silt boom is a cylindrical erosion control device used for slope interruption, perimeter control, and inlet protection. The Silt boom is a fabric skin filled with a filter material designed to slow sediment-laden runoff and process the flow using filtration and temporary ponding.

The purpose of the installation of these products is to reduce uninterrupted slope length to slow the velocity of runoff so as to retain transported sediment from the disturbed areas.

<b>Product Height Class</b>	<b>Installed Height Above Grade (inches)</b>
Class II or approved equal	10-15

Orientation- Silt Boom should be placed on the contour whenever possible but need to be installed between 45 and 90 degrees from the direction of flow.

Overlap 12-24 inches overlap between pieces, shingled in the direction of flow.

Support- Stake or anchor as needed. Staking and anchoring will vary based on the risk of runoff. Staking can be done through the boom or on the downslope side of the boom at an angle where downhill water pressure helps pinch the boom to the ground. The spacing of staking should not be more than 10'. Hardwood 1.5" x 1.5" stakes are preferred and at a length that allows for driving the stake 12" below the surface and leaving a minimum of 2-4" above the boom.

Product Stacking- Silt Boom may be stacked in a pyramid manner (i.e. one on top of two). If sediment accumulates to ½ the height of the boom, then a second boom may be stacked immediately upslope of the original in lieu of removing sediment.

Entrenchment- If the Silt boom is being installed on undisturbed ground entrenchment is counterproductive. If the areas have been disturbed the product can be installed on a flat plane or slightly entrenched. The key point is to address areas where the boom may be undermined such as loose areas of soil or tire tracks and ruts.

Spacing- The spacing is a correlation of class as related to height, length of the slope, and steepness of the slope.

Max spacing (Ft.) per Product Class:

<b>Slope</b>	<b>Class II</b>
<2%	675
2% - 5%	450
5% - 10%	225
10% - 33%	150
>33%	65

Products should be installed prior to disturbing the upslope area.

To protect products from damage in areas of active construction or heavy traffic consider flagging to improve visibility.

To help ensure effectiveness, products should be inspected and repaired as necessary prior to rain events.

Vehicle traffic should be diverted around the product when possible. If vehicle traffic crosses product returns the product to its original position and repair if needed.

Silt booms are to be installed in those locations as shown on the Plans to protect areas as shown.

6. SILT SACKS:

The silt sack to be manufactured from a woven polypropylene geotextile and sewn by a double needle machine, using a high strength nylon thread. The silt sack seams have a certified average wide width strength per ASTM D-4884 standards as follows or approved equal:

Silt sack Style	Test Method	Minimum Values
Regular Flow	ASTM D-4884	165.0lbs./in

The silt sack will be manufactured to fit the opening of the catch basin or drop inlet. The silt sack will have the following features: two dump straps attached at the bottom to facilitate the emptying of the silt sack; the silt sack will also have lifting loops as an integral part of the system to be used to lift the silt sack from the basin. The silt sack will have a restraint cord approximately halfway up the sack to keep the sides away from the catch basin walls, this yellow cord is also a visual means of indicating when the sack should be emptied. Once the strap is covered with sediment, the silt sack should be emptied, cleaned, and placed back into the basin.

The geotextile fabric will be woven polypropylene fabric with the following properties or approved equal:

Silt sack Regular Flow

Property	Test Method	Minimum Value
Grab Tensile	ASTM D-4632	300 lbs.
Grab Elongation	ASTM D-4632	20%
Puncture	ASTM D-4633	120 lbs.
Mullen Burst	ASTM D-3786	800 psi

Trapezoid Tear	ASTM D-4533	120 lbs.
UV Resistance	ASTM D-4355	80%
Apparent Opening	ASTM D-4751	40 US Sieve
Flow Rate	ASTM D-4491	40 Gal/Min/Ft.2
Permittivity	ASTM D-4491	0.55 sec-1

Silt sacks are to be installed in those locations as shown on the Plans to protect newly installed drainage structures and existing drainage structures.

7. EROSION CONTROL BLANKET:

Use 100% biodegradable plant-based products and materials such as jute (vegetable fiber), sisal (stiff agave fiber) or coir (coconut husk fiber) for sedimentation and erosion control within the wetlands and watercourses to be protective of wildlife species such as amphibians, reptiles and birds in the project area. All erosion controls used for the Project shall be removed as soon as soils have been stabilized to avoid impending amphibian and reptile movement between wetlands / watercourses and uplands.

The long-term double net erosion control blanket shall be a machine-produced mat of 100% coconut fiber with functional longevity of up to 24 months. The blanket shall be of consistent thickness with the coconut evenly distributed over the entire area of the mat. The blanket shall be covered on the top and bottom sides with 100% photodegradable woven natural organic fiber netting. The netting shall consist of machine strands formed from two intertwined yarns with cross-directional strands interwoven through the twisted machine strands (commonly referred to as Leno weave) to form an approximate 0.50 x 0.50 mesh. The blanket shall be sewn together on 1.50-inch centers with degradable thread. The blanket shall be manufactured with a colored thread stitched along both outer edges (approximately 2-5 inches from the edge) as an overlap guide for adjacent mats.

The blanket shall meet Type 4 specification requirements established by the Erosion Control Technology Council (ECTC) and Federal Highway Administration's (FHWA) FP-03 Section 713.17

**Material Content**

Matrix	100% Coconut Fiber	0.5 lbs./sq.yd.
Netting	Top: Leno Woven 100% photodegradable jute	9.3 lbs./1,000 sq.ft.

Thread	Black Polypropylene	
<b>Index Property</b>	<b>Test Method</b>	<b>Typical</b>
Thickness	ASTM D6525	0.23 in.
Resiliency	ECTC Guidelines	85%
Water Absorbency	ASTM D1117	365%
Mass/Unit Area	ASTM 6475	9.79 oz/sy
Swell	ECTC Guidelines	40%
Smolder Resistance	ECTC Guidelines	Yes
Stiffness	ASTM D1388	0.11 oz-in
Light Penetration	ASTM D6567	16.2%
Tensile Strength - MD	ASTM D6818	206.4 lbs/ft.
Elongation - MD	ASTM D6818	15.3%
Tensile Strength - TD	ASTM D6818	145.2 lbs/ft.
Elongation - TD	ASTM D6818	12.9%
Biomass Improvement	ASTM D7322	473%
<b>Permissible Shear Stress</b>		
Unvegetated Shear Stress	2.35 psf	
Unvegetated Velocity	10.0 fps	

Include manufacturer's recommended steel wire staples, 6 inches long. Blankets shall be installed with overlap to adjacent mats as specified by the manufacturer. Staples shall be installed using the manufacturer's recommended staple pattern "D" and quantity based on the soil type and application. The matting used shall be specifically intended for "slope stabilization" applications, shall be consistent

with the manufacturer's recommendations for the intended use and shall be on the Connecticut Department of Transportation's "Qualified Product List".

8. CONSTRUCTION ENTRANCE:

The construction entrance is a stone stabilized pad located at points of vehicular ingress and egress on a construction site. The location, dimensions, and details of the construction entrance are shown on the plans and in accordance with these specifications.

The stone used for this work shall conform to the requirements of the State of Connecticut Department of Transportation "Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, as amended and including the current July 2019 supplemental specifications section M.01. Size No. 3.

The fibers in the geotextile used shall consist of synthetic polymers composed of at least 85% by weight polypropylenes, polyesters, polyamides, polyethylene, polyolefin or polyvinyl-chlorides. The fibers shall be formed into a stable network of filaments or yarns, retaining dimensional stability relative to each other. The geotextile used shall be specifically intended for "road stabilization" applications, shall be consistent with the manufacturer's recommendations for the intended use, and shall be on the Connecticut Department of Transportation's "Qualified Product List".

The area of the construction entrance shall be cleared of all vegetation, roots, and other organic or unsuitable material. In poorly drained locations, install subsurface drainage, ensuring the outlet to the drains is free-flowing. If using geotextile in place of free-draining material, unroll the geotextile in a direction parallel to the roadway entrance in a loose manner, permitting it to conform to the surface irregularities when the stone is placed. Unless otherwise specified by the manufacturer, the minimum overlap of geotextile panels joined without sewing according to the manufacturer's recommendations. The geotextile may be temporarily secured with pins recommended or provided by the manufacturer, but they shall be removed prior to placement of the stone. Place the stone according to the locations, dimensions, and depth as shown on the plans.

The construction entrance shall be maintained in a condition that will prevent tracking, flowing, and washing of sediment onto paved surfaces. Provide periodic top dressing with additional stone or additional length as conditions demand. Repair any measures used to trap sediment as needed. Immediately remove all sediment spilled, dropped, washed or tracked onto paved surfaces. Roads adjacent to a construction site shall be left clean at the end of each day.

When the construction entrance is no longer needed or upon project completion, the anti-tracking pad shall be removed in its entirety, and the area shall be restored as directed. The pad materials and sediments shall be removed to a location approved by the Construction Manager or Engineer.

9. SAFETY BARRICADE: The Safety Barricade shall be a temporary, polypropylene construction fence, fully stabilized for UV resistance, with 2 inches by 4.5-inch apertures.
  - a. Color: Orange, height 4' -0".
  - b. Top tension rope – 3/8" braided nylon/polypropylene rope.
10. SAFETY BARRICADE POSTS: Heavy gauge channel steel posts 6' -0" long.
11. ROOT INOCULANT: Inoculant shall be rooting growth hormone-containing mycorrhizae.
12. ANTIRUST COATING: Antirust Coating shall be fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer complying with MPI #23 (surface-tolerant, anticorrosive metal primer) or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.
13. STAGING FENCING: Chain Link Fence, minimum 6'0" height, 11 gauge with 1-1/2" OD posts at 10' -0" maximum on center spacing. Top tension wire required.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Provide erosion-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

#### 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion and sedimentation control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.
- B. Temporary grass cover shall be a quick growing species, suitable to the area, which will provide temporary cover, and will not compete with the grasses sown for permanent cover.
- C. **If temporary or permanent seeding cannot be done within the seeding season, use the temporary erosion control blankets/netting and mulching measures to protect the site and delay seeding until the next recommended seeding period.**



- D. Mulches (chemical or organic) cannot be applied within wetlands or immediately adjacent to wetlands and watercourses to mitigate water quality impacts.
- E. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross-protection zones.
- F. Inspect, maintain, and repair erosion- and sedimentation control measures during construction until permanent vegetation has been established.
- G. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

### 3.3 MAINTENANCE OF EXISTING SITE AREAS

- A. The Contractor shall maintain all temporary and permanent erosion and sediment within the project limits for the duration of the contract.
- B. This maintenance will also disposition of temporary measures
  - 1. All temporary erosion and sediment control measures shall be disposed of within thirty (30) days after final site stabilization is achieved or after the temporary measures are no longer needed as determined by the Owner.
- C. Trapped sediment and other disturbed soil areas resulting from the disposition of temporary measures shall be permanently stabilized to prevent further erosion.
- D. Substantial Completion of Erosion Control Measures:
  - 1. At the time specified in the contract documents, and subject to compliance with specified materials and installation requirements, the Contractor shall receive a Substantial Completion Certificate for temporary erosion control measures.
  - 2. Maintenance of Erosion Control Measures after Substantial Completion:
    - a. The Contractor shall be responsible for maintaining temporary erosion control measures as specified in the drawings and contract documents until such time as work has been accepted by the Owner as specified in Section 017700, Closeout Procedures.
    - b. Include the continuous mowing of undisturbed lawn areas within project limits, as well as the removal of any debris within fenced-off areas.
- E. Final Completion and Acceptance of Erosion Control Measures:
  - 1. After the engineer and Owner have determined that the drainage area has stabilized, the Contractor shall remove all remaining temporary erosion control measures.
  - 2. Any damage to the site shall be repaired to the satisfaction of the engineer and at no cost to the Owner.

END OF SECTION 312500

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SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor, Subcontractors, and/or suppliers providing goods and services referenced in or related to this Section shall also be bound by the Related Documents identified in Division 01 Section "Summary."
- B. Form 817 shall mean the State of Connecticut, Department of Transportation Standard Specifications for Roads, Bridges and Incidental Construction Form 817-2019 July edition and any supplemental specifications.
- C. Report on Geotechnical Engineering Investigation, dated, January 21, 2019, prepared by GNCB Consulting Engineers, P.C.
- D. Summary of Groundwater wells, by GNCB Consulting Engineers, P.C. available upon request.
- E. Particle Size Analysis and Permeability Results, by GNCB Consulting Engineers, P.C. available upon request.

1.2 SUMMARY

- A. The section includes temporary excavation support and protection systems.
- B. Related Sections:
  - 1. Section 015000 - "Temporary Facilities and Controls" for temporary utilities and support facilities.
  - 2. Section 017419 - "Construction and Demolition Waste Management and Disposal."
  - 3. Section 018113 - "Sustainable Design Requirements." for the sustainability requirements of this Project.
  - 4. Section 018119 - "Construction Indoor Air Quality Requirements."
  - 5. Section 312000 - "Earth Moving" for excavating and backfilling and for controlling surface-water runoff and ponding.
  - 6. Section 312319 - "Dewatering" for dewatering excavations.
  - 7. Section 312333 - "Trenching and Backfilling" for trench and pit excavation dewatering
  - 8. Section 330523 - "Horizontal Directional Drilling" for pit excavation dewatering.
  - 9. Section 331000 - "Exterior Water Utilities" for trench and pit excavation dewatering.
  - 10. Section 333000 - "Exterior Sanitary Sewer Utilities" trench and pit excavation dewatering.
  - 11. Section 333200 - "Sanitary Sewage Pump Station" for pit excavation dewatering.
    - a. Section 334000 - "Storm Sewer Utilities" trench and pit excavation dewatering.

- C. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

### 1.3 PRE-INSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.
  - 1. Review the Geotechnical Report.
  - 2. Review existing utilities and subsurface conditions.
  - 3. Review coordination for interruption, shutoff, capping, and continuation of utility services.
  - 4. Review proposed excavations.
  - 5. Review the proposed equipment.
  - 6. Review monitoring of excavation support and protection system.
  - 7. Review coordination with waterproofing.
  - 8. Review abandonment or removal of excavation support and protection system

### 1.4 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High-Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

### 1.5 SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- B. Shop Drawings for Information: Prepared by or under the supervision of a qualified professional engineer licensed in the state of Connecticut for excavation support and protection systems.
  - 1. Include Shop Drawings signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Product Data: For each type of product.

1. Include construction details, material descriptions, performance properties, and dimensions of individual components and profiles, and calculations for excavation support and protection system.
- D. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.
  1. Include plans, elevations, sections, and details.
  2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.
  3. Indicate the type and location of waterproofing.
  4. Include a written plan for excavation support and protection, including a sequence of construction of support and protection coordinated with the progress of excavation.
- E. Qualification Data: For Installer and professional engineer.
- F. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- G. Photographs: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.
- H. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

## 1.6 PROJECT CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:
  1. Notify Owner no fewer than two days in advance of proposed interruption of utility.
  2. Do not proceed with the interruption of utility without Owner's written permission.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by the geotechnical engineer. The Owner will not be responsible for interpretations or conclusions are drawn from the data.
  1. Make additional test borings and conduct other exploratory operations if necessary, for excavation support and protection according to the performance requirements.
  2. The geotechnical report is included in the Project Manual.
- C. Survey Work: Engage a qualified land surveyor to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During the installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Construction Manager and Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## PART 2 - PRODUCTS

### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2–PRODUCTS of Section 018113 – Sustainable Design Requirements.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Provide, design, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
  1. Contractor Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer.
  2. Prevent surface water from entering excavations by grading, dikes, or other means.
  3. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to the excavation.
  4. Continuously monitor vibrations, settlements, and movements to ensure the stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

### 2.3 MATERIALS

- A. General: Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
  1. Corners: Site-fabricated mechanical interlock or Roll-formed corner shape with continuous interlock.
- D. Wood Lagging: Lumber, mixed hardwood, the nominal rough thickness of size and strength required for application 4 inches.
- E. Cast-in-Place Concrete: ACI 301, of compressive strength required for an application.

- F. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- G. Tiebacks: Steel bars, ASTM A 722/A 722M.
- H. Tiebacks: Steel strand, ASTM A 416/A 416M.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.
  - 1. Shore, support and protect utilities encountered.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
  - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from the Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Locate excavation support and protection systems clear of permanent construction so that the forming and finishing of concrete surfaces are not impeded.
- D. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.
- E. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

#### 3.2 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wood lagging within flanges of soldier piles as excavation proceeds. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally to secure soldier piles.

### 3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock to form a continuous barrier.
- B. Accurately place the piling, using templates and guide frames unless otherwise recommended in writing by the sheet-piling manufacturer. Limit vertical offset of adjacent sheet piling to 60 inches. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Cut tops of sheet piling to uniform elevation at top of the excavation.

### 3.4 TIEBACKS

- A. Tiebacks: Drill, install, grout, and tension tiebacks. Test the load-carrying capacity of each tieback and replace and retest deficient tiebacks.
  - 1. Test loading shall be observed by a qualified professional engineer responsible for the design of the excavation support and protection system.
  - 2. Maintain tiebacks in place until permanent construction is able to withstand lateral soil and hydrostatic pressures.

### 3.5 BRACING

- A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing the original brace.
  - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Structural and /or Geotechnical Engineer.
  - 2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
  - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

### 3.6 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during the installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Construction Manager and Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.
- C. Promptly repair damages to adjacent facilities caused by the installation or faulty performance of excavation support and protection systems.



3.7 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bare soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.
  - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon the remainder.
  - 2. Fill voids immediately with approved backfill compacted to density specified in Division 31, Section 312000 "Earth Moving."
  - 3. Repair or replace, as approved by Construction Manager, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

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## SECTION 321216 – ASPHALT PAVING

### PART 1 - GENERAL

#### 1.1 SUMMARY

A. This Section includes the following:

1. Sawcut, demolition, and removal of existing asphalt paving.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. State of Connecticut Department of Transportation "The Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, as amended and merged with the July 2019 supplemental specifications.

#### 1.3 RELATED SECTIONS

1. Section 017419 – "Construction and Demolition Waste Management and Disposal".
2. Section 018113 -"Sustainable Design Requirements" for the sustainability requirements of this project.
3. Section 018119 – "Construction Indoor Air Quality Requirements".
4. Section 312000 - "Earth Moving" for subgrade preparation, structural fill material, unbound-aggregate subbase, and base courses, and aggregate pavement shoulders.
5. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

#### 1.4 SUSTAINABILITY DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High-Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.5 DEFINITION

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.
- B. DOT: Department of Transportation

#### 1.6 PREINSTALLATION MEETINGS

- A. Pre-installation Conference(s): Conduct conference(s) at Project site.
  - 1. Separate pre-installation conferences may be performed for the on-site work and for the asphalt patching required for utility installations. Connecticut Department of Transportation District 4 shall be invited to the pre-installation conference for any work performed within the State Right of Way.
  - 2. Review methods and procedures related to the removal of existing paving and installation of hot-mix asphalt paving including, but not limited to, the following:
    - a. Review proposed sources of paving materials, including capabilities and location of the plant that will manufacture hot-mix asphalt.
    - b. Review the condition of sub-grade and preparatory work.
    - c. Review requirements for protecting paving work, including restriction of traffic during the installation period and for the remainder of the construction period.
    - d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

#### 1.7 SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

- B. Product Data: For each type of product indicated.
  - 1. Include technical data and tested physical and performance properties.
  - 2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
  - 3. Job-Mix Designs: For each job mix proposed for the Work.
  - 4. Pavement marking paint and seal materials.
- C. Qualification Data: For qualified manufacturer and testing agency.
- D. Material Certificates: For each paving material from the manufacturer.
- E. Material Test Reports: For each paving material, by a qualified agency
- F. Field quality-control reports.

#### 1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the State of Connecticut DOT in which the Project is located.
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the State of Connecticut Department of Transportation "Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, including supplemental July 2019 for asphalt paving work.

#### 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement coating materials to the Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.
- B. Store pavement coating materials in a clean, dry, protected location, within the temperature range required by the manufacturer. Protect stored materials from direct sunlight.

#### 1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if sub-grade is wet or excessively damp, if rain is imminent or expected before the time required for an adequate cure, or if the following conditions are not met:

1. Prime Coat: Minimum surface temperature of 60 deg F.
2. Tack Coat: Minimum surface temperature of 60 deg F.
3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
4. Asphalt Base Course: Minimum surface temperature of 40 deg F and rising at the time of placement.
5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at the time of placement.

#### 1.11 COORDINATION

- A. Coordinate all work within the State Right of Way with Connecticut Department of Transportation District 4. Maintenance and protection of traffic within the State Right of Way shall be provided by the Contractor as required by CTDOT.
- B. Coordinate all work within the CT DEEP Maintenance Garage property 422 Watertown Road, Thomaston CT, with Connecticut Department of Energy and Environmental Protection.

### PART 2 - MATERIALS AND PRODUCTS

2.1 For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2—PRODUCTS of Section 018113 – Sustainable Design Requirements.

#### 2.2 Aggregate Courses Under Hot-Mix Asphalt

- A. The processed aggregate base shall conform to the requirements of Section 3.04 and M.05 of the State of Connecticut Department of Transportation "Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, including July 2019 supplemental.

**M.05.01—Processed Aggregate Base and Pavement:** The materials for this work shall meet the following requirements:

1. **Gradation:** Coarse and fine aggregates shall be combined and mixed by approved methods so that the resulting material shall meet the following gradation requirements:

**Table M.05.01-1**

Square Mesh Sieves	Percent Passing by Weight
Pass 2 1/2 inches	100
Pass 2 inches	95-100
Pass 3/4 inch	50-75
Pass 1/4 inch	25-45
Pass No. 40	5-20
Pass No. 100	2-12

**2. Coarse Aggregate:** Coarse aggregate shall be either gravel, broken stone or reclaimed miscellaneous aggregate containing no more than 2% by weight of asphalt cement, at the option of the Contractor. When tested by means of the Los Angeles Machine, using AASHTO Method T 96, the coarse aggregate shall not have a loss of more than 50%.

- (a) If gravel is used for the coarse aggregate, it shall consist of sound, tough, durable particles of crushed or uncrushed gravel or a mixture thereof, free from soft, thin, elongated or laminated pieces, lumps of clay, loam and vegetable or other deleterious substances.
- (b) If broken stone is used for the coarse aggregate, it shall consist of sound, tough, durable fragments of rock of uniform quality throughout. It shall be free from soft disintegrated pieces, mud, dirt, organic or other injurious material.
- (c) If the reclaimed miscellaneous aggregate is used for the coarse aggregate, it shall consist of sound, tough, durable fragments of uniform quality throughout. It shall be free from soft disintegrated pieces, mud, dirt, glass, organic or other injurious material.
- (d) Soundness for Gravel, Broken Stone and Reclaimed Miscellaneous Aggregate: When tested by magnesium sulfate solution for soundness using AASHTO Method T 104, the coarse aggregate shall show a loss of not more than 15% at the end of 5 cycles.

**3. Fine Aggregate:** The fine aggregate shall be natural sand, stone sand, screenings or any combination thereof. The fine aggregate shall be limited to material 95% of which passes a No. 4 sieve having square openings and not more than 8% of which passes a No. 200 sieve. The material shall be free from clay, loam and deleterious materials.

(a) Plasticity: When natural sand is used, the fine aggregate shall conform to the requirements of M.02.06-2.

(b) Plasticity: When screenings or any combination of screenings and natural sand or any combination of stone sand and natural sand are used, the following requirements shall apply:

- 3. When the fraction of the dry sample passing the No. 100 mesh sieve is 6% or less by weight, no plastic limit test will be made.
- 4. When the fraction of the dry sample passing the No. 100 mesh sieve is greater than 6% and not greater than 10% by mass, that fraction shall not have sufficient plasticity to permit the performing of the plastic limit test, using AASHTO Method T 90.
- 5. When the fraction of the dry sample passing the No. 100 mesh sieve is greater than 10% by weight, the sample shall be washed; and additional material passing the No. 100 mesh sieve shall be determined by AASHTO Method T 146, except that the No. 100 mesh sieve shall be substituted for the No. 40 mesh sieve where the latter is specified in AASHTO Method T 146. The combined materials that have passed the No. 100 mesh sieve shall not have sufficient plasticity to permit the performing of the plastic limit test using AASHTO Method T 90.

## 2.3 Hot-Mix Asphalt Materials, including Tack Coat

- A. Bituminous Concrete and Tack Coat shall conform to the requirements of Section 4.06 and M.04 of the State of Connecticut Department of Transportation, "Standard Specifications for Roads, Bridges and Incidental Construction," Form 817, including July 2019 supplemental.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Remove the surface forest mat/topsoil where applicable. Where undisturbed condition exists the natural glacial outwash soil or man-made fill soils are suitable to remain in place below paved areas.
- B. Verify that sub-grade is dry and in suitable condition to begin paving.
- C. Proof-roll sub-grade below pavements by at least 4 passes with a fully loaded dump truck or heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated sub-grades.
  - 1. Completely proof-roll sub-grade in one direction, repeating proof-rolling in the direction perpendicular to the first direction. Limit vehicle speed to 3 mph.
  - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
  - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Construction Manager and/or Engineer, and replace with compacted backfill or fill as directed.
- D. Proceed with paving only after unsatisfactory conditions have been corrected.
- E. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

### 3.2 PATCHING

- A. Asphalt Pavement: Saw cut the perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into the perimeter of adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Re-compact existing unbound-aggregate base course to form a new subgrade.
- B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseal concrete pieces firmly.
  - 1. Pump hot undersealing asphalt under the rocking slab until the slab is stabilized or, if necessary, crack slab into pieces and roll to reseal pieces firmly.
  - 2. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into the perimeter of adjacent sound pavement, unless otherwise



indicated. Cut excavation faces vertically. Re-compact existing unbound-aggregate base course to form a new subgrade.

- C. Tack Coat: Before placing patch material, apply tack coat uniformly to vertical asphalt surfaces abutting the patch. Apply at a rate of 0.05 to 0.15 gal./sq. yd.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
- D. Placing Patch Material: Fill excavated pavement areas with hot-mix asphalt base mix for the full thickness of patch and, while still hot, compact flush with the adjacent surface.
- E. Placing Patch Material: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

### 3.3 REPAIRS

- A. Leveling Course: Install and compact leveling course consisting of hot-mix asphalt surface course to level sags and fill depressions deeper than 1 inch in existing pavements.
  - 1. Install leveling wedges in compacted lifts not exceeding 3 inches thick.
- B. Crack and Joint Filling: Remove existing joint filler material from cracks or joints to a depth of 1/4 inch.
  - 1. Clean cracks and joints in existing hot-mix asphalt pavement.
  - 2. Use emulsified-asphalt slurry to seal cracks and joints less than 1/4 inch wide. Fill flush with the surface of existing pavement and remove excess.
  - 3. Use a hot-applied joint sealant to seal cracks and joints more than 1/4 inch wide. Fill flush with the surface of existing pavement and remove excess.

### 3.4 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that the prepared sub-grade is ready to receive paving.
- B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd.
  - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
  - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

### 3.5 HOT-MIX ASPHALT PLACING

- A. Machine place hot-mix asphalt on the prepared surface spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross-section, and thickness when compacted.
  - 1. Place the hot-mix asphalt base course in the number of lifts and thicknesses indicated in the table below.
  - 2. Place hot-mix asphalt surface course in a single lift and thicknesses indicated in the table below.
  - 3. Spread mix at a minimum temperature of 250 deg F.
  - 4. Begin applying mix along the centerline of crown for crowned sections and on the high side of one-way slopes unless otherwise indicated.
  - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in the asphalt-paving mat.
  
- B. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.
  - 1. After the first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches from strip to strip to ensure proper compaction of the mix along longitudinal joints.
  - 2. Complete a section of the asphalt base course before placing the asphalt surface course.
  
- C. Promptly correct surface irregularities in the paving course behind the paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

### 3.6 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with the same texture and smoothness as other sections of the hot-mix asphalt course.
  - 1. Clean contact surfaces and apply a tack coat to joints.
  - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
  - 3. Offset transverse joints, in successive courses, a minimum of 24 inches.
  - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
  - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
  - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

### 3.7 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
  - 1. Complete compaction before mix temperature cools to 185 deg F.
- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for the indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.
- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
  - 1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent nor greater than 100 percent.
  - 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While the surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on the pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until the mixture has cooled enough not to become marked.

### 3.8 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  - 1. Base Course: Plus or minus 1/2 inch.
  - 2. Surface Course: Plus 1/4 inch, no minus.

- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:
  - 1. Base Course: 1/4 inch.
  - 2. Surface Course: 1/8 inch.
  - 3. Crowned Surfaces: Test with crowned template centered and at a right angle to the crown. The maximum allowable variance from the template is 1/4 inch.

### 3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: the Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. In-Place Density: the Testing agency will take samples of un-compacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
  - 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
  - 2. The in-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
    - a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
    - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- E. Replace and compact hot-mix asphalt where core tests were taken.
- F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

### 3.10 PAVEMENT WARRANTY

- A. The Contractor shall warrant and guarantee the quality of materials and workmanship to be free of any defects for a period of five years from the date of installation of asphalt pavement. This will include: any cracks larger than 1/8-inch wide will be filled with crack filler; tire scuff

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marks will be heated and re-tamped; and any heaving and/or sagging of the pavement in excess of the original installation specification tolerances. This Unconditional Warranty does not include damage caused by oil spills and normal wear and tear.

3.11 DISPOSAL

- A. Except for material indicated to be recycled, remove excavated materials from the Project site and legally dispose of them in a CT DEEP approved landfill.

3.12 AS-BUILT

- A. Provide a record drawing of all constructed items prepared by a Licensed Land Surveyor licensed in Connecticut. Provide a statement that the as-built record conforms with the design, or as acceptable by the design engineer. As-built to be prepared in a paper, Mylar and AutoCAD format and provided to the Owner.

END OF SECTION 321216

## SECTION 321313 - CONCRETE PAVING

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes Concrete Paving Including the Following:
  - 1. Concrete Walks, curb ramps and steps.
  - 2. Reinforced Concrete Walks.
  - 3. Concrete Walks with Integral Curbing.
  - 4. Tactile Warning Surfacing.
  - 5. Concrete Paving Joint Sealants
- B. Related Requirements:
  - 1. Section 017419 “Construction and Demolition Waste Management and Disposal.
  - 2. Section 018113 “Sustainable Design Requirements”
  - 3. Division 03 for general building applications of concrete.
  - 4. Section 312000 “Earth Moving” for base and sub-base materials and compaction requirements.

#### 1.3 DEFINITIONS

- A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash, slag cement, and other pozzolans.
- B. W/C Ratio: The ratio by weight of water to cementitious materials.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to concrete paving, including but not limited to, the following:
    - a. Concrete mixture design.
    - b. Quality control of concrete materials and concrete paving construction practices.
  - 2. Require representatives of each entity directly concerned with concrete paving to attend, including the following:

- a. Contractor's superintendent.
- b. Concrete paving Subcontractor.

#### 1.5 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- C. Samples for Initial Selection: For each type of product, ingredient, or admixture requiring color selection.
- D. Samples for Verification: For each type of product or exposed finish, prepared as Samples of size indicated below:
- E. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified ready-mix concrete manufacturer.
- B. Material Certificates: For the following, from manufacturer:
  - 1. Cementitious materials.
  - 2. Steel reinforcement and reinforcement accessories.
  - 3. Admixtures.
  - 4. Curing compounds.
  - 5. Applied finish materials.
  - 6. Bonding agent or epoxy adhesive.



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7. Joint fillers.

C. Material Test Reports: For each of the following:

1. Aggregates: Include service-record data indicating absence of deleterious expansion of concrete due to alkali-aggregate reactivity.

D. Field quality-control reports.

## 1.8 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C94/C94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

B. Mockups: Build mockups to verify selections made under 1.6.D. above and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Build mockups of full-thickness sections of concrete paving to demonstrate typical joints; surface finish, texture, and color; curing; and standard of workmanship.
2. Build mockups of concrete paving where directed by Architect and not less than 96 inches (2400 mm) by 96 inches (2400 mm).
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

## 1.9 FIELD CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

B. Cold-Weather Concrete Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:

1. When air temperature has fallen to or is expected to fall below 40 deg F (4.4 deg C), uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F (10 deg C) and not more than 80 deg F (27 deg C) at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.

- C. Hot-Weather Concrete Placement: Comply with ACI 301 (ACI 301M) and as follows when hot-weather conditions exist:
1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
  2. Cover steel reinforcement with water-soaked burlap, so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

## PART 2 - PRODUCTS

### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements

### 2.2 CONCRETE, GENERAL

- A. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

### 2.3 FORMS

- A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, and smooth exposed surfaces.
1. Use flexible or uniformly curved forms for curves with a radius of 100 feet (30.5 m) or less. Do not use notched and bent forms.
- B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and that will not impair subsequent treatments of concrete surfaces.

### 2.4 STEEL REINFORCEMENT

- A. Recycled Content of Steel Products: Postconsumer recycled content plus one-half of preconsumer recycled content not less than 60 percent.
- B. Epoxy-Coated Welded-Wire Reinforcement: ASTM A884/A884M, Class A, plain steel.
- C. Epoxy-Coated Reinforcing Bars: ASTM A775/A775M or ASTM A934/A934M; with ASTM A615/A615M, Grade 60 (Grade 420) deformed bars.

- D. Epoxy-Coated-Steel Wire: ASTM A884/A884M, Class A; coated, deformed.
- E. Epoxy-Coated, Joint Dowel Bars: ASTM A775/A775M; with ASTM A615/A615M, Grade 60 (Grade 420) plain-steel bars.
- F. Tie Bars: ASTM A615/A615M, Grade 60 (Grade 420); deformed.
- G. Hook Bolts: ASTM A307, Grade A (ASTM F568M, Property Class 4.6), internally and externally threaded. Design hook-bolt joint assembly to hold coupling against paving form and in position during concreting operations, and to permit removal without damage to concrete or hook bolt.
- H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded-wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified, and as follows:
  - 1. Equip wire bar supports with sand plates or horizontal runners where base material will not support chair legs.
  - 2. For epoxy-coated reinforcement, use epoxy-coated or other dielectric-polymer-coated wire bar supports.
- I. Epoxy Repair Coating: Liquid, two-part, epoxy repair coating, compatible with epoxy coating on reinforcement.

## 2.5 CONCRETE MATERIALS

- A. Regional Materials: Concrete shall be manufactured within 100 miles (160 km) of Project site from aggregates and cementitious materials that have been extracted, harvested, or recovered, as well as manufactured, within 100 miles (160 km) of Project site.
- B. Cementitious Materials: Use the following cementitious materials, of same type, brand, and source throughout Project:
  - 1. Portland Cement: ASTM C150/C150M, gray portland cement Type I/II.
  - 2. Fly Ash: ASTM C618, Class F.
  - 3. Blended Hydraulic Cement: ASTM C595/C595M, Type IS, portland blast-furnace slag Type IP, portland-pozzolan cement.
- C. Normal-Weight Aggregates: ASTM C33/C33M, Class 4S, uniformly graded. Provide aggregates from a single source with documented service-record data of at least 10 years' satisfactory service in similar paving applications and service conditions using similar aggregates and cementitious materials.
  - 1. Maximum Coarse-Aggregate Size: 1-1/2 inches (38 mm) nominal.
  - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- D. Air-Entraining Admixture: ASTM C260/C260M.

- E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.
  - 1. Water-Reducing Admixture: ASTM C494/C494M, Type A.
  - 2. Retarding Admixture: ASTM C494/C494M, Type B.
  - 3. Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type D.
  - 4. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F.
  - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C494/C494M, Type G.
  - 6. Plasticizing and Retarding Admixture: ASTM C1017/C1017M, Type II.
- F. Water: Potable and complying with ASTM C94/C94M.

## 2.6 CURING MATERIALS

- A. Moisture-Retaining Cover: ASTM C171, polyethylene film or white burlap-polyethylene sheet.
- B. Water: Potable.
- C. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C309, Type 1, Class B, dissipating.

## 2.7 RELATED MATERIALS

- A. Joint Fillers: semi-rigid, closed-cell polypropylene foam, preformed joint filler that meets the following physical property requirements and fully complies with ASTM D8139.
  - 1. Compression Strength      30-60 psi      per ASTM D 545 or AASHTO T 42
  - 2. Compression Recovery      > 80%      per ASTM D 545 or AASHTO T 42
  - 3. Extrusion      < 0.1 in.      per ASTM D 545 or AASHTO T 42
  - 4. Density      >3.5 lbs./cu.ft.      per ASTM D 545 or AASHTO T 42
  - 5. Water Absorption      < 1.0%      per ASTM D 545 or AASHTO T 42
  - 6. Heat Resistance °F      392°F± 5°F      per ASTM D 5249
  - 7. Freeze Thaw Resistance      No change      per ASTM C 666 (300 cycles)
  - 8. UV Weathering      No change      per ASTM D 4329 (1000 hrs., Cycle A)
  - 9. Thickness      3/8 inch typical, 1/2 inch where walk abuts structures
  - 10. Provide cutting tool for pre-scoring the top edge of the joint filler, to allow removal of top portion for sealant application.
- B. Joint Sealant for horizontal applications: Two component polyurethane elastomeric type complying with FS-TT-S-00227, self-leveling designed for foot traffic, 2c SL, as manufactured by SIKA, Pecora. Subject to compliance with requirements, provide the specified product or comparable product of BASF MasterSeal NP2 Sealant or LymTal International Iso-Flex 881 R Sealant.
  - 1. Color to be selected by Landscape Architect.

- C. Joint Sealant for vertical applications: Two component polyurethane elastomeric type complying with FS-TT-S-00230, non-sag, 2c NS EZ Mix, as manufactured by SIKA, Pecora. Subject to compliance with requirements, provide the specified product or comparable product of BASF MasterSeal NP2 Sealant or LymTal International Iso-Flex 881 R Sealant.
  - 1. Color to be selected by Landscape Architect.
- D. Sealant Backer Rod: Compressible rod stock or polyethylene foam, polyethylene jacketed, butyl rubber foam, or neoprene foam, as recommended by sealant manufacturer where required for back-up of sealant.
- E. Grout: Non-shrink, non-staining grout.

## 2.8 DETECTABLE WARNING SQUARE CAST IRON PAVER MATERIALS

- A. Detectable Warning Square Cast Iron Paver Materials shall be a minimum of 60% post-consumer recycled content.
- B. Detectable Warning Square Cast Iron Paver: 24 Inch x 24 inch paver.
  - 1. Straight and radial detectable square cast iron paver warning plates shall be ADA II/ABA compliant, with slip resistant surface.
  - 2. Plate shall be heavy duty grey iron, compliant with ASTM A48 CL35B.
  - 3. 24 inch width of tactile warning strip for dimensioned lengths, unless otherwise indicated on plans.
  - 4. Provide radius sections as required to meet back of curb radii in project drawings.
  - 5. Detectable Warning paver shall be manufactured with integral anchor lugs to ensure solid attachment to cast-in-place concrete.
    - a. Cast iron paver shall be undipped Grey iron.
    - b. Rust conditioner coating to be factory applied by the manufacturer.

## 2.9 CONCRETE MIXTURES

- A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), for each type and strength of normal-weight concrete, and as determined by either laboratory trial mixtures or field experience.
  - 1. Use a qualified independent testing agency for preparing and reporting proposed concrete design mixtures for the trial batch method.
  - 2. When automatic machine placement is used, determine design mixtures and obtain laboratory test results that comply with or exceed requirements.
- B. Cementitious Materials: Limit percentage, by weight, of cementitious materials other than portland cement in concrete as follows:
  - 1. Fly Ash or Pozzolan: 25 percent.
  - 2. Slag Cement: 50 percent.

- C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:
  - 1. Air Content: 6 percent plus or minus 1-1/2 percent for 1-inch (25-mm) nominal maximum aggregate size.
- D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.
- E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
  - 1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.
- F. Concrete Mixtures: Normal-weight concrete.
  - 1. Compressive Strength (28 Days): 4500 psi (31 MPa).
  - 2. Maximum W/C Ratio at Point of Placement: 0.45.
  - 3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
  - 4. Solar Reflectance (SR): Three-year-aged SR value of at least 0.28 or initial SR of at least 0.33.

## 2.10 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C94/C94M and ASTM C1116/C1116M. Furnish batch certificates for each batch discharged and used in the Work.
  - 1. When air temperature is between 85 and 90 deg F (30 and 32 deg C), reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
  - 1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph (5 km/h).
  - 2. Proof-roll with a pneumatic-tired and loaded, 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
  - 3. Correct subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch (13 mm) according to requirements in Section 312000 "Earth Moving."

- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

### 3.3 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

### 3.4 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space, and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded-wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.
- E. Epoxy-Coated Reinforcement: Use epoxy-coated steel wire ties to fasten epoxy-coated reinforcement. Repair cut and damaged epoxy coatings with epoxy repair coating according to ASTM D3963/D3963M.

### 3.5 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
  - 1. When joining existing paving, place transverse joints to align with previously placed joints unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.



1. Continue steel reinforcement across construction joints unless otherwise indicated. Do not continue reinforcement through sides of paving strips unless otherwise indicated.
  2. Provide tie bars at sides of paving strips where indicated.
  3. Butt Joints: Use bonding agent at joint locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
  4. Keyed Joints: Provide preformed keyway-section forms or bulkhead forms with keys unless otherwise indicated. Embed keys at least 1-1/2 inches (38 mm) into concrete.
  5. Doweled Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat with asphalt one-half of dowel length to prevent concrete bonding to one side of joint.
- C. Expansion/Isolation Joints: Form expansion/isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
1. Locate expansion joints at intervals of 20 feet unless otherwise indicated.
  2. Extend joint fillers full width and depth of joint.
  3. Doweled Expansion Joints: Install dowel bars and support assemblies at joints where indicated. Lubricate or coat one-half of dowel length to prevent concrete bonding to one side of joint.
  4. Pre-score the top edge of the joint filler with the manufacturer provided cutter tool. Install the joint filler system so that either the top edge of joint filler is at or slightly below the intended concrete surface.
  5. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
  6. Remove top scored portion of joint filler after concrete has been placed and cured on both sides of joint.
- D. Tooled/Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:
1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch (6-mm) radius. Repeat grooving of contraction joints after applying surface finishes.
  2. Sawed Joints: Form contraction joints with power saws equipped with shatterproof abrasive or diamond-rimmed blades. Cut 1/8-inch- (3-mm-) wide joints into concrete when cutting action will not tear, abrade, or otherwise damage surface and before developing random contraction cracks.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes.
- 3.6 CONCRETE PLACEMENT
- A. Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast-in.



- B. Remove snow, ice, or frost from subbase surface and steel reinforcement before placing concrete. Do not place concrete on frozen surfaces.
- C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.
- D. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, and placing concrete.
- E. Do not add water to concrete during delivery or at Project site. Do not add water to fresh concrete after testing.
- F. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- G. Consolidate concrete according to ACI 301 (ACI 301M) by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.
  - 1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels and joint devices.
- H. Screed paving surface with a straightedge and strike off.
- I. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleedwater appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.
- J. Cold-Weather Placement: Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing, or low temperatures. Comply with ACI 306.1 and the following:
  - 1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
  - 2. Do not use frozen materials or materials containing ice or snow.
  - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in design mixtures.
- K. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:
  - 1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated in total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.

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2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
  3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

### 3.7 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleedwater sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
  1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface, perpendicular to line of traffic, to provide a uniform, fine-line texture.

### 3.8 DETECTABLE WARNING SQUARE CAST IRON PAVER

- A. Install detectable warning in accordance with manufacturer's instructions at locations indicated on the drawings.
- B. Any cutting required to fit detectable warning to an abutting piece, shall be done making every effort that cut line does not bisect the tactile domes, but falls between them. If cuts do bisect a dome, then the edge of the cut dome must be ground to meet ADA requirements for change in vertical grades. Cut pieces shall be dry fitted to ensure tight butt joint between plates prior to placing tactile warning in wet concrete.
- C. Set pavers in wet concrete at final position. Keep wet concrete off of the top surface of the pavers at all times.
- D. Press pavers into wet concrete to final elevation.
- E. Finish concrete around assembled pavers.
- F. Pavers must be flush with abutting concrete surface and flush curbing.

### 3.9 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during

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finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by moisture curing, curing compound or a combination of these as follows:
  - 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
    - a. Water.
    - b. Continuous water-fog spray.
    - c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch (300-mm) lap over adjacent absorptive covers.
  - 2. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating, and repair damage during curing period.

### 3.10 SEALANT INSTALLATION

- A. Install joint sealant in all expansion joints in accordance with manufacturer's installation instructions. Remove dust, dirt and loose material. Clean and prime joints.
- B. Apply sealants in continuous beads, without open joints, voids, or air pockets. Hand tool and finish all joints.
- C. Confine materials to joint areas with masking tape or other precautions. Insure joint sealing is cleanly executed with no override onto adjacent pavement.
- D. Remove excess compound promptly as work progresses and clean adjoining surfaces. Protect until fully cured.
- E. In rough surfaces or joints of uneven widths, hold joint sealant well back into joints.

### 3.11 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 (ACI 117M) and as follows:
  - 1. Elevation: 1/4 inch (6 mm).
  - 2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
  - 3. Surface: Gap below 10-foot- (3-m-) long; unlevelled straightedge not to exceed 1/2 inch (13 mm).
  - 4. Alignment of Tie-Bar End Relative to Line Perpendicular to Paving Edge: 1/2 inch per 12 inches (13 mm per 300 mm) of tie bar.
  - 5. Lateral Alignment and Spacing of Dowels: 1 inch (25 mm).

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6. Vertical Alignment of Dowels: 1/4 inch (6 mm).
  7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Paving Edge: 1/4 inch per 12 inches (6 mm per 300 mm) of dowel.
  8. Joint Spacing: 3 inches (75 mm).
  9. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
  10. Joint Width: Plus 1/8 inch (3 mm), no minus.

### 3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Services: Testing and inspecting of composite samples of fresh concrete obtained according to ASTM C172/C172M shall be performed according to the following requirements:
  1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. (76 cu. m) or fraction thereof of each concrete mixture placed each day.
    - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
  2. Slump: ASTM C143/C143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
  3. Air Content: ASTM C231/C231M, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
  4. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F (4.4 deg C) and below and when it is 80 deg F (27 deg C) and above, and one test for each composite sample.
  5. Compression Test Specimens: ASTM C31/C31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.
  6. Compressive-Strength Tests: ASTM C39/C39M; test one specimen at seven days and two specimens at 28 days.
    - a. A compressive-strength test shall be the average compressive strength from two specimens obtained from same composite sample and tested at 28 days.
- C. Strength of each concrete mixture will be satisfactory if average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi (3.4 MPa).
- D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

- E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.
- G. Concrete paving will be considered defective if it does not pass tests and inspections.
- H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- I. Prepare test and inspection reports.

### 3.13 REPAIR AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.
- B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory paving areas with portland cement concrete bonded to paving with epoxy adhesive.
- C. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- D. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

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SECTION 321613 - PRECAST CONCRETE CURBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Precast concrete curbs.
- B. Related Requirements:
  - 1. Section 017419 "Construction and Demolition Waste Management and Disposal".
  - 2. Section 018113 "Sustainable Design Requirements".
  - 3. Section 321216 "Asphalt Paving" for asphalt base under unit pavers.
  - 4. Section 321313 "Concrete Paving".

1.3 REFERENCE STANDARDS

- A. Form 817 shall mean the State of Connecticut, Department of Transportation Standard specifications for Roads, Bridges and Incidental Construction, Form 817-2019 or its latest edition and any supplemental specifications.

1.4 PERMITS/APPROVALS

- A. Obtain approval of construction and secure all permits for work in R.O.W. areas. Contractor shall be licensed to R.O.W. holder and pay all fees.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.6 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

### 1.7 SUBMITTALS

- A. Product Data: For materials other than water and aggregates.
- B. Product Data: For the following:
  - 1. Precast concrete curbs.
- C. Connecticut High Performance Building Submittals:
  - 1. Recycled content materials.
  - 2. Local materials.
- D. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store precast concrete curbing on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

### 1.9 FIELD CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.
- B. Weather Limitations for Mortar and Grout:
  - 1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.
  - 2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F (38 deg C) and higher.
    - a. When ambient temperature exceeds 100 deg F (38 deg C), or when wind velocity exceeds 8 mph (13 km/h) and ambient temperature exceeds 90 deg F (32 deg C), set pavers within 1 minute of spreading setting-bed mortar.

## PART 2 - PRODUCTS

### 2.1 LEED PERFORMANCE REQUIREMENTS



- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

## 2.2 MANUFACTURERS

- A. Source Limitations: Obtain each type of curb, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

## 2.3 CURBS

- A. Precast Concrete Curbs: conform to Form 817 Article M.03.01 Class F and the following:
  - 1. Minimum 28 days compressive strength of 5,000 psi
  - 2. Air entrainment: 5 to 7 percent.
- B. Minimum length:
  - 1. Straight curbing – 80% of the curbs shall be furnished in lengths of not less than 6 feet, and the remaining 20% in lengths of not less than 4 feet, interspersed at random, to allow for closures.
  - 2. Radius curbing – **curbs to be set on a radius of 100 feet or less shall be cast to the curve required, and their ends shall be cast on radial lines. This includes interanal and external faced radius curbs.** Requirements for length of individual curbs in curved curbing vary with radii of curves.
  - 3. **Provide radius curb where indicated on the drawings.**
- C. Special pieces: provide slope transition curbs, 180-degree bullnose, 90-degree driveway corners, and other special pieces as indicated.

## 2.4 ACCESSORIES

- A. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas indicated to receive curbing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION, GENERAL

- A. Do not use curbing with chips, cracks, voids, discolorations, or other defects that might be visible in finished work.
- B. Curbing:
  - 1. Install curbing to the lines, grades, and details shown in the drawings. Conform to Form 817 Article 8.11.03, for precast concrete curbing; and the following requirements:

- a. Subgrade
  - 1) Insure all utility conduit have been installed prior to backfill/subgrade preparation. Prepare subgrade by removing all soft or spongy material and backfilling with suitable material.
  - 2) Compact the surface uniformly to 95% Modified AASHTO Laboratory density (ASTM D-1557, Method C).
  - 3) Coordinate testing of subgrade and base with the Owner. Do not install base materials until schedule testing procedures are complete.
- b. Base
  - 1) Place maximum 6" layers.
  - 2) Compact each layer uniformly to 95% Modified AASHTO Laboratory density (ASTM D-1557, Method C).
- c. Curb Installation
  - 1) Set on edge. Settle into place with a heavy wooden hand rammer.
  - 2) Joints:
    - a) Place concrete at the curb joints as shown on the drawings. Insure that top exposed edge of curb face is consistent and true to line and grade. Support curb as required until concrete cures and all backfill operations have been completed.
    - b) Point joints with mortar for the full depth and width of curbing. Conform to the details on the drawings.
    - c) Omit concrete bed and mortar joint at 50 (+/-) foot intervals along curb installation to allow for expansion.
  - 3) Backfill with approved material.

### 3.3 REPAIRING AND CLEANING

- A. Remove and replace curbing sections that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.
- B. Cleaning: Remove excess grout from exposed curbing surfaces; wash and scrub clean.

END OF SECTION 321613

## SECTION 321723 – PAVEMENT MARKINGS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Pavement markings, including parking space striping and cross-hatching, ADA accessible reserved parking space symbols, electric vehicle parking space symbols, and stop bars.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. State of Connecticut Department of Transportation “The Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, as amended and merged with the current July 2019 supplemental specifications.
- C. Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD).

#### 1.3 RELATED SECTIONS

- A. Section 321216 - “Asphalt Paving”.
- B. Section 017419 – “Construction and Demolition Waste Management and Disposal”.
- C. Section 018113 – “Sustainable Design Requirements”.
- D. Section 018119 – “Construction Indoor Air Quality Requirements”.
- E. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

#### 1.4 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project’s environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut’s High-Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN

REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.5 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.
  - 1. Review methods and procedures related to paving markings including, but not limited to, the following:
    - a. Review requirements for protecting pavement markings, including restriction of traffic during the installation period and for the remainder of the construction period.

#### 1.6 SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- B. Product Data: For each type of product indicated.
  - 1. Include technical data and tested physical and performance properties.
  - 2. Pavement marking paint materials.
- C. Material Certificates: For pavement material, from the manufacturer.

#### 1.7 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of the State of Connecticut Department of Transportation "Standard Specifications for Roads, Bridges and Incidental Construction", Form 817 including July 2019 supplemental for asphalt paving work.

#### 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pavement-marking materials to the Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

- B. Store pavement-marking materials in a clean, dry, protected location within the temperature range required by the manufacturer. Protect stored materials from direct sunlight.

## 1.9 PROJECT CONDITIONS

- A. Pavement-Marking Paint Coating: Proceed with pavement marking and pavement coating only on clean, dry surfaces and at a minimum ambient or surface temperature as noted below in this specification for different pavement makings and applications.

## PART 2 - PRODUCTS

### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

### 2.2 PAVEMENT MARKINGS

- A. Painted pavement markings, as noted on the plans, shall conform to the requirements of Section 12.10 and M.07 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including current July 2019 supplemental.
  - 1. Epoxy resin pavement markings
    - a. This item shall consist of furnishing and installing retroreflective white and yellow epoxy resin pavement markings of the width and color specified and epoxy resin pavement markings at the locations indicated on the plans and in conformity with the plans, these specifications and as directed by the Construction Manager and /or Engineer.
    - b. Epoxy resin pavement markings include epoxy resin installed with a truck-mounted machine such as centerlines, lane lines, and shoulder lines.
    - c. Epoxy resin pavement markings include: parking stalls, and markings within areas such as paved islands, gore areas and paved medians.
    - d. Materials for this work shall conform to the requirements of Article M.07.22.
    - e. Equipment furnished shall include an applicator truck of adequate size and power, together with remote application equipment designed to apply an epoxy resin material in a continuous pattern and portable glass bead applicators, one for each size bead, designed to provide uniform and complete coverage of the epoxy binder by a controlled free-fall method. Pressurized glass bead application shall not be

- used. Before the epoxy color is changed, equipment shall be cleaned out sufficiently to ensure that the color of the material applied will be correct.
- f. When working on a road, it is the contractor's responsibility for insuring vehicle and pedestrian traffic and worker's safety. Its cost shall be included in the bid price for this item.
  - g. For markings applied on pavements over one-year-old, equipment furnished shall also include a power washing machine capable of cleaning the pavement with a pressure of 2,400 to 2,800 psi with water heated to 180° F - 195° F. No chemicals shall be added to the water used in the process. The power washer shall be equipped with a turbo blast tip with an oscillating head and shall be capable of supplying a minimum of 5 gallons/minute gun.
  - h. All guns on the spray carriages shall be in full view of the operator(s) during operation.
  - i. Each vehicle furnished shall include at least one experienced operator, who shall be fully knowledgeable about all equipment operations and application techniques.
  - j. The Contractor shall also furnish one technical expert, who shall be fully knowledgeable about all equipment operations and application techniques, to oversee the project operation.
  - k. Pavement markings shall be applied in accordance with the details shown on the plans and the control points established by the Contractor and approved by the Construction Manager.
  - l. The road surface shall be cleaned at the direction of the Construction Manager just prior to application. Pavement cleaning shall consist of power washing using clean water heated to 180° F - 195° F at a pressure of 2,240 - 2,800 psi. The areas to be power washed shall include all areas where epoxy markings are to be applied and at least 1 inch beyond the area to be marked. The surface shall be cleaned to the satisfaction of the Construction Manager. For other pavement areas, cleaning shall consist of brushing with a rotary broom (non-metallic), and any additional work as recommended by the material manufacturer and acceptable to the Construction Manager and /or Engineer. New Portland cement concrete surfaces shall be cleaned by abrasive blasting to remove any surface treatments and/or laitance. New bituminous concrete surfaces are not to be power washed.
  - m. All surfaces that are power washed shall be allowed to dry sufficiently prior to the application of the epoxy markings. The areas to be marked shall be broom cleaned immediately prior to the application of the epoxy markings. Glass beads shall be applied immediately after application of the epoxy resin marking to provide an immediate no-track system.
  - n. The Contractor will place necessary "spotting" at appropriate points to provide horizontal control for striping and to determine necessary starting and cutoff points. Broken line intervals will not be marked. Longitudinal joints, pavement edges and existing markings shall serve as horizontal control when so directed.

- o. A tolerance of 0.25 inch under or 0.25 inch over the specified width shall be allowed for striping provided the variation is gradual and does not detract from the general appearance. Alignment deviations from the control guide shall not exceed 2 inches provided the variation is gradual and does not detract from the general appearance. Material shall not be applied over a longitudinal joint. The establishment of application tolerances shall not relieve the Contractor of the responsibility to comply as closely as practicable with the planned dimensions.
  - p. Operations shall be conducted only when the road surface temperature is at least 40° F. They shall be discontinued during periods of rain and shall not continue until the Construction Manager determines that the pavement surface is dry enough to achieve adhesion.
  - q. The epoxy shall be uniformly applied to the surface to be marked to ensure a wet film thickness of the applied epoxy, without glass beads, of 20 mils +/- 1 mil.
  - r. Glass beads conforming to the requirements of Grading "B" (larger beads) shall be applied at a rate of 12 pounds per gallon of epoxy pavement marking material, immediately followed by a second drop of glass beads conforming to the requirements of Grading "A" (smaller beads) applied at a rate of 13 pounds per gallon of epoxy pavement marking material. Traffic cones, barricades, or some other acceptable method shall be used to protect the pavement markings until cured.
  - s. The material shall be in "no-tracking" condition within 15 minutes, or as allowed by the Construction Manager. The no-tracking time shall be determined by passing over the line with a passenger car or pickup truck in the simulated passing maneuver. A marking showing no visual deposition of the material to the pavement surface when viewed from a distance of 50 feet shall be considered as showing "no-tracking" and conforming to this requirement for time to no-track.
  - t. When stencils are used during the application of epoxy markings, care must be used when removing the stencils so that the epoxy resin does not drip on the road, sidewalk, grass, etc., and so that the applied markings have edges which are clean, straight and neat.
- B. Epoxy resin pavement markings may be applied over existing painted markings provided they are sufficiently worn to allow adequate adhesion. If required by the Construction Manager, existing plastic, thermoplastic, epoxy or freshly painted markings shall be removed prior to the application of epoxy markings.
- C. Stop bars, parking space lines, and hatches, ADA symbols, crosswalks, and road shoulder lines shall be white in color.
- D. Road centerlines shall be yellow in color.
- E. Dimensions and locations as specified on the drawings.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that finished asphalt grade is dry and in suitable condition to begin painting.
- B. Do not apply pavement-marking paint coating until layout, colors, and placement have been verified with Construction Manager and /or Engineer.

#### 3.2 PAVEMENT MARKING

- A. Marking-paint manufacturers caution that paint will bleed or tear the surface of new asphalt unless asphalt is aged before painting. This aging period may vary from 30 to 90 days. If pavement marking must proceed immediately, apply a phased application of a thin first coat followed by a thicker second coat once asphalt has aged. Two-coat application is recommended.

#### 3.3 PAVEMENT MARKINGS ACCEPTANCE AND WARRANTY:

- A. In order to be accepted, the applied markings must meet the following minimum retroreflectivity reading as measured using an LTL 2000 Retrometer with 30-meter geometry 1 to 2 weeks after installation:
- B. White Epoxy 250 millicandelas per square foot per foot-candle (millicandelas per square meter per lux)
- C. Yellow Epoxy 175 millicandelas per square foot per foot-candle (millicandelas per square meter per lux)
- D. The Contractor shall warrant for the period and percentage level indicated below that the installation shall remain intact and serviceable. The installed material shall show no fading, lifting, shrinking, tearing, rollback, distortion or chipping due to vehicular traffic or normal maintenance activities including snow plowing. Although some wear is expected, the markings shall not wear out for the period and percentage level indicated below.
- E. First Year
  - 1. Epoxy Resin Pavement Markings 95% linear feet.
  - 2. Epoxy Resin Pavement Markings, Symbols and Legends 95% square feet.
- F. In addition, the epoxy resin pavement markings shall be warranted to retain a minimum retroreflective value of 150 millicandelas per foot-candle (lux) per square foot (square meter)



one year after installation. The measurements shall be made utilizing an LTL 2000 Retrometer with 30-meter geometry.

- G. Determination of percentages of serviceability and minimum retroreflective values will be made jointly at the end of 1 year by the Contractor's representative and by the Construction Manager and /or Engineer. The decision of the Construction Manager and /or Engineer shall be final. The term "percentage of serviceability" shall be defined as follows: The percentage of serviceability of the markings shall apply to the total linear feet for particular Pavement Markings and total square feet for the particular Pavement Markings, Symbols, and Legends measured on the project for payment.
- H. The Contractor shall replace, entirely at the Contractor's expense, such amount of markings, if any, required to meet the above-stated percentage. The Construction Manager and /or Engineer will indicate the areas and lines to be replaced to meet the above-stated percentages. The Contractor shall also replace those markings that fail the minimum value for retroreflectivity. Replacement under either situation shall include all materials, equipment, labor and work incidental thereto.
- I. The Contractor shall provide to the Owner, at no extra cost, any manufacturer's warranties or guarantees that exceed the minimum requirements stated previously, that are normally provided by the manufacturer.
- J. These written warranties shall be provided when the documentation for the product is provided.

#### 3.4 DISPOSAL

- A. Except for material indicated to be recycled, remove unsuitable paint materials from the Project site and legally dispose of them in a CT DEEP approved landfill.

#### 3.5 AS-BUILT

- A. Provide a record drawing of all constructed items prepared by a Licensed Land Surveyor licensed in Connecticut. Provide a statement that the as-built record conforms with the design, or as acceptable by the design engineer. As-built to be prepared in a paper, Mylar and AutoCad format and provided to the Owner.

END OF SECTION 321723

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SECTION 321724 – TRAFFIC SIGNS

PART 1 - GENERAL

1.1 SUMMARY

- A. Sign Face Sheet Aluminum – Bright Wide Angle Reflective Sheeting
- B. Sign Face Sheet Aluminum – Type I Reflective Sheeting
- C. Sign Face Sheet Aluminum – Type III Reflective Sheeting
- D. Signs, including stop sign and red retroreflective strip, ADA accessible reserved parking space sign, visitor parking space sign, electric vehicle space sign, and employee parking only sign.
- E. Sign appurtenances, including breakaway metal signpost and sign-mounting bolts.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. State of Connecticut Department of Transportation “The Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, as amended and merged with the July 2019 supplemental specifications.
- C. Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD).
- D. AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals”, 2001.

1.3 RELATED SECTIONS

- A. Section 017419 – “Construction and Demolition Waste Management and Disposal”.
- B. Section 018113 – “Sustainable Design Requirements”.
- C. Section 018119 – “Construction Indoor Air Quality Requirements”.
- D. Section 312000 - “Earthmoving” for excavation.

#### 1.4 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High-Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.5 SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- B. Product Data: For each type of product.

### PART 2 - PRODUCTS

#### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

#### 2.2 SIGNS

- A. Sign Face Sheet Aluminum – Bright Wide Angle Reflective Sheeting shall conform to the requirements of Section 12.08 and Article M.18.09, M.18.13, M.18.14 and M.18.15 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including July 2019 supplement, and notes and details included on the plans.
- B. Sign Face Sheet Aluminum – Type I Reflective Sheeting shall conform to the requirements of Section 12.08 and Article M.18.09, M.18.13, M.18.14 and M.18.15 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges, and Incidental Construction”, Form 817, including July 2019 supplement, and notes and details included on the plans.

- C. Sign Face Sheet Aluminum – Type III Reflective Sheeting shall conform to the requirements of Section 12.08 and Article M.18.09, M.18.13, M.18.14 and M.18.15 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges, and Incidental Construction”, Form 817, including supplement, and notes and details included on the plans.
- D. Sign mounting shall be the U-channel, V-Lock socket systems, and as indicated on construction documents details sheets.
- E. Stop sign and red retroreflective strip
  - 1. Sheeting Type IX
  - 2. Background color: Red
  - 3. Stop sign dimensions: 30” x 30”
  - 4. Retroreflective strip dimensions: 4” x 72”
- F. Pedestrian Crossing sign and Arrow subplate sign
  - 1. Sheeting Type IX
  - 2. Background color: Yellow
  - 3. Pedestrian Crossing sign dimensions: 30” x 30”
  - 4. Arrow subplate sign dimensions: 24” x 12”
- G. ADA accessible reserved parking space sign and ADA Van-accessible reserved parking space placard
  - 1. Sheeting Type IX
  - 2. Background color: White
  - 3. ADA accessible parking space sign dimensions: 12” x 18”
  - 4. ADA Van-accessible parking space placard dimensions: 12” x 6”
  - 5. Utilize the Modified International Symbol of Access as shown on the drawings
- H. Visitor parking space sign
  - 1. Sheeting Type IX
  - 2. Background color: White
  - 3. Visitor parking space sign dimensions: 12” x 18”
- I. Electric Vehicle space sign
  - 1. Sheeting Type IX
  - 2. Background color: White
  - 3. Electric vehicle space sign dimensions: 12” x 18”
- J. Employee Parking Only sign
  - 1. Sheeting Type IX
  - 2. Background color: White
  - 3. Employee parking only sign dimensions: 20” x 20”

2.3 SIGN APPURTENANCES

- A. Breakaway metal signpost: Conform to Form 817 including July 2019 supplemental Article M.18.14 Metal Sign Posts. Provide breakaway features that meet AASHTO “Standard Specifications for Structural Supports for Highway Signs, Luminaires, and Traffic Signals.”
- B. Sign-mounting bolts: Conform to Form 817, including July 2019 supplement Article M.18.15 Sign-Mounting Bolts.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All work shall be in accordance with Section 12.08.03 of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including July 2019 supplement and notes and details included on the plans.

3.2 AS-BUILT

- A. Provide an As-Built of all signs installed, including the type consistent with the design descriptions.

END OF SECTION 321724

## SECTION 323300 - SITE FURNISHINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

##### A. Section Includes:

1. Seating.
2. Bicycle racks.
3. Trash/Recycle receptacles.
4. Timber Guide rail.
5. Metal Pipe Bollards, including removable bollards, sleeves and sleeve covers.

##### B. Related Requirements:

1. Section 017419 "Construction and Demolition Waste Management and Disposal".
2. Section 018113 "Sustainable Design Requirements."
3. Section 312000 "Earth Moving" for excavation for installing concrete footings.
4. Section 321313 "Concrete Paving" for anchor of site furnishings to concrete pavement.

#### 1.3 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the

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Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: For units with factory-applied finishes.
- E. Samples for Verification: For each type of exposed finish, not less than 6-inch- (152-mm-) long linear components and 4-inch- (102-mm-) square sheet components.

#### 1.5 INFORMATIONAL SUBMITTALS

- A. Material Certificates: For site furnishings manufactured with preservative-treated wood.
  - 1. Indicate type of preservative used and net amount of preservative retained. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.

#### 1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

#### 1.7 WARRANTY FOR SITE FURNISHINGS

- A. Structural
  - 1. Minimum ten-year structural warranty on metal and galvanized components.
- B. Finish
  - 1. Minimum three-year warranty against rusting, peeling, chipping, cracking, mold, mildew, and defects in materials and/or workmanship;
  - 2. Minimum seven-year warranty against fading.

### PART 2 - PRODUCTS

#### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

#### 2.2 SEATING

- A. Bench (Metal-with back)
  - 1. Basis of Design Standard: Allure Thermory 6' Contour Bench, Model # AL1980T, as manufactured by Anova Furnishings, 211 North Lindbergh Blvd., St. Louis, MO 63141



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- anovafurnishings.com. Subject to compliance with requirements, provide the named product, or comparable product of Model MLB1200 series as manufactured by Maglin Site Furniture, (800) 716-5506 [www.maglin.com](http://www.maglin.com) or Model FGB as manufactured by Landscape Forms (800) 521-2546 [www.landscapeforms.com](http://www.landscapeforms.com).
2. The bench is 72.50" long and will support 200lbs per linear foot.
  3. Material:
    - a. Frame:
      - 1) cast aluminum legs
      - 2) steel under supports.
    - b. Seat (with Back):
      - 1) The 6' flat bench is composed of 1" x 2" Thermory seat and back planks, with aluminum accent planks, cast aluminum legs and steel under supports.
      - 2) Low-maintenance Thermory is made from thermally-modified North American White Ash—a sustainably-harvested and renewable temperate hardwood. It is an environmentally-friendly hardwood and a great alternative to commonly used tropical rainforest hardwoods because of its dimensional stability and Class 1 durability (25+ years). Thermory has a lower carbon footprint than tropical hardwoods.
  4. Surface Mount: Contractor to provide stainless steel mounting hardware. The bench feet have predrilled .4" diameter holes for surface mounting to prevent movement.
  5. Finish: Fade-resistant, powder coated steel and aluminum components feature a state-of-the-art primer proven to prevent rusting. Treated components exceed the industry standard by 34% in testing by independent sources.
    - a. Thermory is a lustrous chocolate brown color when new and will naturally age to uniform silver/gray over time. The color-changing process begins immediately and varies with the amount of UV-exposure.
    - b. Color: To be selected by the Landscape Architect from full range of manufacturers standard colors.

### 2.3 BICYCLE RACKS

- A. Basis of Design Standard: "Loop" bicycle rack as manufactured by Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, MI 49048. 800 521-2546 [www.landscapeforms.com](http://www.landscapeforms.com). Subject to compliance with requirements, provide the named product, or comparable product of Model SCBR1600 Series as manufactured by Maglin Site Furniture, (800) 716-5506 [www.maglin.com](http://www.maglin.com) or Model EP 5950 Ipe as manufactured by Equiparc, (800) 363-9264 [www.equipaqr.com](http://www.equipaqr.com).
  1. Material:
    - a. Frame: Aluminum Casting – A356 ASTM B108 or A360 ASTM B108 & LFI 7.4.2-A1
  2. Embedded Mount:
    - a. Embedded Hardware Pack: (2) ½-13 UNC-2A fully threaded rods, 5" length, with Magni-coat.
  3. Finishes:
    - a. Primer: Rust inhibitor
    - b. Topcoat: Thermosetting TGIC polyester powder coat. UV, chip and flake resistant.

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- c. Test Results: Pangard II
    - 1) Gloss consistency, Gardner 60 Degrees, ASTM D 523: Plus or minus 5 percent from standard.
    - 2) UV Resistance, Color and Bloss, ASTM G 155, Cycle 7: Delta E less than 2 at 2.0 mils and less than 20 percent loss.
    - 3) Cross-Hatch Adhesion, ASTM D 3359, Method B: 100 percent pass.
    - 4) Flexibility Test, Mandrel, ASTM D 522: 3mm at 2 mils.
    - 5) Erichsen Cupping, ISO 1520: 8mm.
    - 6) Impression Hardness, Buchholz, ISO 2815: 95.
    - 7) Impact Test, ASTM D 2794: 60 inch-pounds at 2.5 mils.
    - 8) Pencil Hardness, ASTM D 3363: 2H minimum.
    - 9) Corrosion Resistance, 1,500-Hour Test, ASTM B 117: Max undercutting 1 mm.
    - 10) Humidity Resistance, 1,500-Hour Test, ASTM D 2247: Max blisters 1 mm.
  - d. Color: Color as selected by Architect from manufacturer's full range including standard colors, premium colors, custom colors, exotic colors and metallic colors.

## 2.4 TRASH AND RECYCLE RECEPTACLES

- A. Basis of Design Standard: "Lakeside" litter receptacle as manufactured by Landscape Forms, Inc., 431 Lawndale Avenue, Kalamazoo, MI 49048. 800 521-2546 [www.landscapeforms.com](http://www.landscapeforms.com). Subject to compliance with requirements, provide the named product, or comparable product of Model MLWR650-32 Series as manufactured by Maglin Site Furniture, (800) 716-5506 [www.maglin.com](http://www.maglin.com) or Model Universal Litter & Recycling Receptacle as manufactured by Forms + Surfaces, (800) 451-0410 [www.forms-surfaces.com](http://www.forms-surfaces.com).
  - 1. Style:
    - a. Side-Opening
    - b. Capacity- 30 Gallons.
    - c. Height: 36 ¼ inches
    - d. Diameter: 21 inches
    - e. Top: 20" diameter x 1-1/4" tall at top of dome
  - 2. Material:
    - a. Top: spun 14 gauge spun steel.
    - b. Liner: Constructed of linear low density polyethylene with 0.100" nominal wall thickness. Color of liner to be selected by Architect.
    - c. Body: Constructed of 10 gauge HRPO steel welded to a 2" tall toe ring. Side opening litter bodies have (2) 10 ¾" x 5 ¼" openings.
  - 3. Surface Mount: Contractor to provide stainless steel anchor bolts.
  - 4. Finish: Custom laser cut pattern.
    - a. Color: Color to be selected by the Architect from the full selection of "powder coated metal" metallic series colors.
  - 5. Each receptacle will have manufacturer provided and installed placard indicating "Trash" or "Recycle" at openings.

## 2.5 TIMBER GUIDE RAIL

- A. Timbers:
  - 1. Rough sawn, No. 2 or better Southern Yellow Pine timbers.
  - 2. AWWA Standard U1, with .40 lbs., p.c.f. retention of waterborne ACQ-D preservative.
  - 3. Kiln dried or air dried before and after treatment or 25% maximum moisture content.

## 2.6 METAL PIPE BOLLARDS

- A. Fabricate to the dimensions as indicated in the drawings.
  - 1. Metal Pipe Bollard Construction:
    - a. Metals, General: Conform to Section 055000 Metal Fabrications.
    - b. Steel and Iron: Conform to Section 055000 Metal Fabrications.
    - c. Fabrication: Conform to Section 055000 Metal Fabrications.
    - d. Bollard Finish: Hot-Dip galvanized
    - e. Sleeve Finish: Stainless Steel
  - 2. Style:
    - a. Dimensions: As indicated in the Drawings.
- B. Metal Pipe Bollards shall be installed as indicated on the Drawings.
- C. Concrete: State of Connecticut Department of Transportation Standard Specifications for Roads, Bridges, and Incidental Construction Form 817-2016, including current Supplements, Article M.03.01, Class "C".

## 2.7 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment: Pressure-treat wood according to AWWA U1, Use Category UC3b, and the following:
  - 1. Use preservative chemicals acceptable to authorities having jurisdiction and containing no arsenic or chromium. Use chemical formulations that do not bleed through or otherwise adversely affect finishes. Do not use colorants to distinguish treated materials from untreated materials.
  - 2. Kiln-dry lumber and plywood after treatment to a maximum moisture content, respectively, of 19 and 15 percent. Do not use materials that are warped or do not comply with requirements for untreated materials.

## 2.8 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.

- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Preservative-Treated Wood Components: Complete fabrication of treated items before treatment if possible. If cut after treatment, apply field treatment complying with AWPA M4 to cut surfaces.
- E. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- F. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

## 2.9 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

## 2.10 ALUMINUM FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

## 2.11 STEEL AND GALVANIZED-STEEL FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored and positioned at locations indicated on Drawings.
- D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

END OF SECTION 323300

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SECTION 323313 – WALL-MOUNTED BIKE RACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section Includes:
  - 1. Wall-mounted bicycle racks.
- B. Related Requirements:
  - 1. Section 017419 “Construction and Demolition Waste Management and Disposal”.
  - 2. Section 018113 “Sustainable Design Requirements.”

1.3 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project’s environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut’s High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project’s target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project’s sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project’s sustainability goals and LEED certification.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project’s LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: For units with factory-applied finishes.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

2.2 BICYCLE RACKS

- A. Basis of Design Standard: “The Stirrup” bicycle rack as manufactured by Huntco Site Furnishings. P.O. Box 10385, Portland Oregon 97296. 503-224-8700 [www.huntco.com](http://www.huntco.com). Subject to compliance with requirements, provide the named product, or comparable product of another manufacturer, including but not limited to:

1. Dero, a Playcore Company, Ultra Spacesaver, Single
2. Belson Outdoors, Single Storage Rack

- B. Material:

1. Frame: Powder-coated Steel
2. Wall Mount: manufacturer’s standard wall anchors
3. Color: Color as selected by Architect from manufacturer's full range including standard colors.

2.3 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended, so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.



- D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- E. Factory Assembly: Factory assemble components to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

#### 2.4 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

#### 2.5 STEEL AND GALVANIZED-STEEL FINISHES

- A. Powder-Coat Finish: Manufacturer's standard polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 INSTALLATION

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install bike racks after building finishes are complete.
- C. Install level, plumb, true, and securely anchored and positioned at locations indicated on Drawings.

END OF SECTION 323300

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SECTION 329115 - SOIL PREPARATION (PERFORMANCE SPECIFICATION)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. Section includes planting soils specified according to performance requirements of the mixes.
- B. Restoration of site stockpiled surface soil and borrow topsoil to meet the requirements of the reference plantings soil in Article xx of this section.
- C. Related Requirements:
  - 1. Section 015000 "Temporary Facilities & Controls".
  - 2. Section 015639 "Temporary Tree and Plant Protection" for Vegetation and Soil Protection Zones.
  - 3. Section 017419 "Construction and Demolition Waste Management and Disposal".
  - 4. Section 018113 "Sustainable Design Requirements."
  - 5. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
  - 6. Section 312000 "Earth Moving" for rough grading and base material below landscaped and planted surfaces.
  - 7. Section 329200 "Turf and Grasses" for placing planting soil for turf and grasses.
  - 8. Section 329300 "Plants".

1.3 DEFINITIONS

- A. AAPFCO: Association of American Plant Food Control Officials.
- B. Backfill: The earth used to replace or the act of replacing earth in an excavation. This can be amended or unamended soil as indicated.
- C. CEC: Cation exchange capacity.
- D. Compost: The product resulting from the controlled biological decomposition of organic material that has been sanitized through the generation of heat and stabilized to the point that it is beneficial to plant growth.
- E. Duff Layer: A surface layer of soil, typical of forested areas, that is composed of mostly decayed leaves, twigs, and detritus.
- F. Imported Soil: Soil that is transported to Project site for use.

- G. Layered Soil Assembly: A designed series of planting soils, layered on each other, that together produce an environment for plant growth.
  - H. Manufactured Soil: Soil produced by blending soils, sand, stabilized organic soil amendments, and other materials to produce planting soil.
  - I. NAPT: North American Proficiency Testing Program. An SSSA program to assist soil-, plant-, and water-testing laboratories through interlaboratory sample exchanges and statistical evaluation of analytical data.
  - J. Organic Matter: The total of organic materials in soil exclusive of undecayed plant and animal tissues, their partial decomposition products, and the soil biomass; also called "humus" or "soil organic matter."
  - K. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified as specified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
  - L. RCRA Metals: Hazardous metals identified by the EPA under the Resource Conservation and Recovery Act.
  - M. SSSA: Soil Science Society of America.
  - N. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
  - O. Subsoil: Soil beneath the level of subgrade; soil beneath the topsoil layers of a naturally occurring soil profile, typified by less than 1 percent organic matter and few soil organisms.
  - P. Surface Soil: Soil that is present at the top layer of the existing soil profile. In undisturbed areas, surface soil is typically called "topsoil"; but in disturbed areas such as urban environments, the surface soil can be subsoil.
  - Q. USCC: U.S. Composting Council.
- 1.4 PREINSTALLATION MEETINGS
- A. Preinstallation Conference: Conduct conference at Project site.
- 1.5 SUSTAINABLE DESIGN REQUIREMENTS
- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design

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goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.6 ACTION SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- B. Product Data: For each type of product.
  - 1. Include recommendations for application and use.
  - 2. Include test data substantiating that products comply with requirements.
  - 3. Include sieve analyses for aggregate materials.
  - 4. Material Certificates: For each type of imported soil and soil amendment and fertilizer before delivery to the site, according to the following:
    - a. Manufacturer's qualified testing agency's certified analysis of standard products.
    - b. Analysis of fertilizers, by a qualified testing agency, made according to AAPFCO methods for testing and labeling and according to AAPFCO's SUIP #25.
    - c. Analysis of nonstandard materials, by a qualified testing agency, made according to SSSA methods, where applicable.
- C. Samples: For each bulk-supplied material, 1-quart (1-L) volume of each in sealed containers labeled with content, source, and date obtained. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of composition, color, and texture.

#### 1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For each testing agency.
- B. Preconstruction Test Reports: For preconstruction soil analyses specified in "Preconstruction Testing" Article.
- C. Field quality-control reports.

#### 1.8 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent, state-operated, or university-operated laboratory; experienced in soil science, soil testing, and plant nutrition; with the experience and capability to conduct the testing indicated; and that specializes in types of tests to be performed.
  - 1. Laboratories: Subject to compliance with requirements, provide testing by the following:

- a. UCONN Soil Nutrient Analysis Laboratory, 6 Sherman Place, Unit 5102, Storrs, CT 06269-5102 (860) 486-4274 [soiltest@uconn.edu](mailto:soiltest@uconn.edu).
- b. UMASS Soil & Plant Nutrient Testing Lab, 203 Paige Laboratory, 161 Holdsworth Way, Amherst, MA 01003 (413) 545-2311 [soiltest@umass.edu](mailto:soiltest@umass.edu)

#### 1.9 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction soil analyses on existing, on-site soil and imported soil.
  - 1. Notify Architect seven days in advance of the dates and times when laboratory samples will be taken.
- B. Preconstruction Soil Analyses: For each unamended soil type, perform testing on soil samples and furnish soil analysis and a written report containing soil-amendment and fertilizer recommendations by a qualified testing agency performing the testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
  - 1. Have testing agency identify and label samples and test reports according to sample collection and labeling requirements.

#### 1.10 SOIL-SAMPLING REQUIREMENTS

- A. General: Extract soil samples according to requirements in this article.
- B. Sample Collection and Labeling: Have samples taken and labeled by Contractor in presence of Architect under the direction of the testing agency.
  - 1. Number and Location of Samples: Minimum of three representative soil samples from varied locations for each soil to be used or amended for landscaping purposes.
  - 2. Procedures and Depth of Samples: According to USDA-NRCS's "Field Book for Describing and Sampling Soils."
  - 3. Division of Samples: Split each sample into two, equal parts. Send half to the testing agency and half to Owner for its records.
  - 4. Labeling: Label each sample with the date, location keyed to a site plan or other location system, visible soil condition, and sampling depth.

#### 1.11 TESTING REQUIREMENTS

- A. General: Perform tests on soil samples according to requirements in this article.
- B. Physical Testing:

1. Soil Texture: Soil-particle, size-distribution analysis by both of the following methods according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods":
    - a. Sieving Method: Report sand-gradation percentages for very coarse, coarse, medium, fine, and very fine sand; and fragment-gradation (gravel) percentages for fine, medium, and coarse fragments; according to USDA sand and fragment sizes.
    - b. Hydrometer Method: Report percentages of **GRAVEL**, sand, silt, and clay.
  2. Total Porosity: Calculate using particle density and bulk density according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  3. Water Retention: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  4. Saturated Hydraulic Conductivity: According to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods"; at 85 percent compaction according to ASTM D1557 (modified proctor).
- C. Chemical Testing:
1. CEC: Analysis by sodium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 3- Chemical Methods."
  2. Clay Mineralogy: Analysis and estimated percentage of expandable clay minerals using CEC by ammonium saturation at pH 7 according to SSSA's "Methods of Soil Analysis - Part 1-Physical and Mineralogical Methods."
  3. Metals Hazardous to Human Health: Test for presence and quantities of RCRA metals including aluminum, arsenic, barium, copper, cadmium, chromium, cobalt, lead, lithium, and vanadium. If RCRA metals are present, include recommendations for corrective action.
  4. Phytotoxicity: Test for plant-available concentrations of phytotoxic minerals including aluminum, arsenic, barium, cadmium, chlorides, chromium, cobalt, copper, lead, lithium, mercury, nickel, selenium, silver, sodium, strontium, tin, titanium, vanadium, and zinc. A simple germination test may be used for this purpose.
- D. Fertility Testing: Soil fertility analysis according to standard laboratory protocol of SSSA NAFT NEC-67, including the following:
1. Percentage of organic matter.
  2. CEC, calcium percent of CEC, and magnesium percent of CEC.
  3. Soil reaction (acidity/alkalinity pH value).
  4. Nitrogen ppm. and Nitrate-N
  5. Phosphorous ppm.
  6. Potassium ppm.
  7. Manganese ppm.
  8. Manganese-availability ppm.
  9. Zinc ppm.
  10. Zinc availability ppm.
  11. Copper ppm.
  12. Iron ppm.
  13. Boron ppm.
  14. Aluminum ppm.

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15. Sodium ppm and sodium absorption ratio.
  16. Soluble-salts ppm.
  17. Presence and quantities of problem materials including salts and metals cited in the Standard protocol. If such problem materials are present, provide additional recommendations for corrective action.
  18. Other deleterious materials, including their characteristics and content of each.
- E. Organic-Matter Content: Analysis using loss-by-ignition method according to SSSA's "Methods of Soil Analysis - Part 3-Chemical Methods."
- F. Recommendations: Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated to produce satisfactory planting soil suitable for healthy, viable plants indicated. Include, at a minimum, recommendations for nitrogen, phosphorous, and potassium fertilization, and for micronutrients.
1. Fertilizers and Soil Amendment Rates: State recommendations in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm)depth of soil.
  2. Soil Reaction: State the recommended liming rates for raising pH or sulfur for lowering pH according to the buffered acidity or buffered alkalinity in weight per 1000 sq. ft. (100 sq. m) for 6-inch (150-mm)depth of soil.

#### 1.12 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and compliance with state and Federal laws if applicable.
- B. Bulk Materials:
1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  3. Do not move or handle materials when they are wet or frozen.
  4. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

### PART 2 - PRODUCTS

#### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.



## 2.2 REFERENCE SOIL

- A. The reference soil for the project site per the NRCS Web Soil Survey is Hinckley (38A, 38C & 38E). The Hinckley series consists of very deep, excessively drained soils formed in glaciofluvial materials.
  - 1. Hinckley 38A has slopes between 0 and 3 percent.
  - 2. Hinckley 38C has slopes between 3 and 15 percent.
  - 3. Hinckley 38E has slopes between 15 and 35 percent.
  
- B. Hinckley Soil Texture
  - 1. OE Horizon is moderately decomposed plant materials at a depth of 0 to 1 inch.
  - 2. A Horizon is loamy sand at a depth of 1 to 8”
  - 3. Bw1 Horizon is gravelly loamy sand at a depth of 8 to 11 inches.
  - 4. Bw2 Horizon is gravelly loamy sand at a depth of 11 to 16 inches.
  
- C. Hinckley Soil Organic Matter
  - 1. OE Horizon is 95 percent organic matter at a depth of 0 to 1 inch.
  - 2. A Horizon is 5.5 percent organic matter at a depth of 1 to 8”
  - 3. Bw1 Horizon is 0.5 percent organic matter at a depth of 8 to 11 inches.
  - 4. Bw2 Horizon is 0.3 percent organic matter at a depth of 11 to 16 inches.
  
- D. Hinckley Soil Cation Exchange
  - 1. OE Horizon has effective cation exchange of 26-55 at a depth of 0 to 1 inch.
  - 2. A Horizon has effective cation exchange of 0.1 to 6.6 at a depth of 1 to 8”
  - 3. Bw1 Horizon has effective cation exchange of 0.0 to 2.8 at a depth of 8 to 11 inches.
  - 4. Bw2 Horizon has effective cation exchange of 0.0 to 2.1 at a depth of 11 to 16 inches.
  
- E. Hinckley Soil Reaction/pH
  - 1. OE Horizon has a soil reaction/pH of 3.8 to 4.8 at a depth of 0 to 1 inch.
  - 2. A Horizon has a soil reaction/pH of 3.5 to 6.0 at a depth of 1 to 8”
  - 3. Bw1 Horizon has a soil reaction/pH of 3.5 to 6.0 at a depth of 8 to 11 inches.
  - 4. Bw2 Horizon has a soil reaction/pH of 3.5 to 6.0 at a depth of 11 to 16 inches.
  
- F. Hinckley Soil Salinity
  - 1. All horizons have a salinity of 0.0 to 1.9.

## 2.3 PLANTING SOILS SPECIFIED ACCORDING TO PERFORMANCE REQUIREMENTS

- A. Planting soils materials shall be 100% regionally extracted.
  
- B. Planting-Soil Type I: Existing, on-site surface soil, with the duff layer, if any, retained; and stockpiled on-site; modified to produce viable planting soil similar to the OE and A horizons of the Reference Soil indicated in Article 2.2 above. Using preconstruction soil analyses and materials specified in other articles of this Section, amend existing, on-site surface soil to become planting soil complying with the following requirements:
  - 1. Particle Size Distribution by USDA Textures: Classified as loamy sand soil according to USDA textures.

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2. Percentage of Organic Matter: Minimum 5 to 8 percent by volume.
  3. Soil Reaction: pH of 6 to 6.6.
  4. Fertility: N, P, K, Mg, and Ca in amounts recommended by the testing laboratory for the turf types and plant groups to be installed.
  5. RCRA Metals: Below maximum limits established by the EPA.
  6. Phytotoxicity: Below phytotoxicity limits established by SSSA.
- C. Planting-Soil Type II: Imported, naturally formed soil from off-site sources and consisting of loamy sand or sandy loam soil according to USDA textures; and modified to produce viable planting soil similar to the OE and A horizons of the Reference Soil indicated in Article 2.2 above. Amend imported soil with materials specified in other articles of this Section to become planting soil complying with the following requirements:
1. Sources: Take imported, unamended soil from sources that are naturally well-drained sites where topsoil occurs at least 4 inches (100 mm) deep, not from bogs, or marshes; and that do not contain undesirable organisms; disease-causing plant pathogens; or obnoxious weeds and invasive plants including, but not limited to, quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass.
  2. Additional Properties of Imported Soil before Amending: Minimum of 5 percent organic-matter content, friable, and with sufficient structure to give good tilth and aeration. Clean soil to be of the following:
    - a. Unacceptable Materials: Concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
    - b. Unsuitable Materials: Stones, roots, plants, sod, clay lumps, and pockets of coarse sand that exceed a combined maximum of 5 percent by dry weight of the imported soil.
    - c. Large Materials: Stones, clods, roots, clay lumps, and pockets of coarse sand exceeding 1 ¼ inches in any dimension.
  3. Percentage of Organic Matter: Minimum 5 to 8 percent by volume.
  4. Soil Reaction: pH of 6 to 6.6.
  5. Fertility: N, P, K, Mg, and Ca in amounts recommended by the testing laboratory for the turf types and plant groups to be installed.
  6. RCRA Metals: Below maximum limits established by the EPA.
  7. Phytotoxicity: Below phytotoxicity limits established by SSSA.

## 2.4 INORGANIC SOIL AMENDMENTS

- A. Lime: ASTM C602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:
1. Percent by weight passing through square mesh sieves:
    - a. 100 percent passing No. 10 sieve.
    - b. Minimum 90 percent passing No. 20 sieve.
    - c. Minimum 40 percent passing No. 100 sieve.
  2. Form: Provide lime in form of ground dolomitic limestone.

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- B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent elemental sulfur, with a minimum of 99 percent passing through a No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through a No. 40 (0.425-mm) sieve.
  - C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.
  - D. Sand: Clean, washed, natural or manufactured, free of toxic materials, and according to ASTM C33/C33M.

## 2.5 ORGANIC SOIL AMENDMENTS

- A. Compost: Well-composted, stable, and weed-free organic matter produced by composting feedstock, and bearing USCC's "Seal of Testing Assurance," and as follows:
  - 1. Feedstock: Limited to leaves.
  - 2. Reaction: pH of 5.5 to 8.
  - 3. Soluble-Salt Concentration: Less than 4 dS/m.
  - 4. Moisture Content: 35 to 55 percent by weight.
  - 5. Organic-Matter Content: 40 to 60 percent of dry weight.
  - 6. Particle Size: Minimum of 98 percent passing through a 3/4-inch sieve.

## 2.6 FERTILIZERS

- A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified testing agency.
- D. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. Place planting soil and fertilizers according to requirements in other Specification Sections.
- B. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in planting soil.
- C. Proceed with placement only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION OF UNAMENDED, ON-SITE SOIL BEFORE AMENDING

- A. Excavation: Excavate soil from designated area(s) to a depth of 6 inches (150 mm) and stockpile until amended per Section 311000 Site Clearing.
- B. Unacceptable Materials: Clean soil of concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials that are harmful to plant growth.
- C. Unsuitable Materials: Clean soil to contain a combined maximum of 8 percent by dry weight of stones, roots, plants, sod, clay lumps, and pockets of coarse sand.
- D. Topsoil to be respread as planting soil for conservation/wildlife mix areas and pollinator mix areas shall not be screened.
- E. Remove subsoil and nonsoil materials from topsoil to be used as planting soil for lawn turf areas, including clay lumps, gravel, and other objects larger than 2 inches (50 mm) in diameter; trash, debris, weeds, roots, and other waste materials.
  - 1. Screening: Pass unamended soil through a 2-inch (50-mm) sieve to remove large materials.

#### 3.3 PLACING AND MIXING PLANTING SOIL OVER EXPOSED SUBGRADE

- A. General: Apply and mix unamended soil with amendments on-site to produce required planting soil. Do not apply materials or till if existing soil or subgrade is frozen, muddy, or excessively wet.
- B. Subgrade Preparation: Till subgrade to a minimum depth of 4 inches (100 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
  - 1. Apply, add soil amendments, and mix approximately half the thickness of unamended soil over prepared, loosened subgrade according to "Mixing" Paragraph below. Mix thoroughly into top 2 inches (50 mm) of subgrade. Spread remainder of planting soil.

- C. Compaction: Compact each blended lift of planting soil to 75 to 82 percent of maximum Standard Proctor density according to ASTM D1557.
- D. Finish Grading: Grade planting soil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

### 3.4 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
  - 1. Compaction: Test planting-soil compaction after placing each lift and at completion using a densitometer or soil-compaction meter calibrated to a reference test value based on laboratory testing according to ASTM D1557. Space tests at no less than one for each 1000 sq. ft. (100 sq. m) of in-place soil or part thereof.
  - 2. Performance Testing: For each amended planting-soil type, demonstrating compliance with specified performance requirements. Perform testing according to "Soil-Sampling Requirements" and "Testing Requirements" articles.
- C. Soil will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. Label each sample and test report with the date, location keyed to a site plan or other location system, visible conditions when and where sample was taken, and sampling depth.

### 3.5 PROTECTION

- A. Protection Zone: Identify protection zones according to Section 015639 "Temporary Tree and Plant Protection."
- B. Protect areas of in-place soil from additional compaction, disturbance, and contamination. Prohibit the following practices within these areas except as required to perform planting operations:
  - 1. Storage of construction materials, debris, or excavated material.
  - 2. Parking vehicles or equipment.
  - 3. Vehicle traffic.
  - 4. Foot traffic.
  - 5. Erection of sheds or structures.
  - 6. Impoundment of water.
  - 7. Excavation or other digging unless otherwise indicated.
- C. If planting soil or subgrade is overcompacted, disturbed, or contaminated by foreign or deleterious materials or liquids, remove the planting soil and contamination; restore the subgrade as directed by Architect and replace contaminated planting soil with new planting soil.

3.6 CLEANING

- A. Protect areas adjacent to planting-soil preparation and placement areas from contamination. Keep adjacent paving and construction clean and work area in an orderly condition.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable materials, trash, and debris and legally dispose of them off Owner's property unless otherwise indicated.

END OF SECTION 329115

SECTION 329200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section Includes:

1. Seeding.
2. Hydroseeding.
3. No-mow/low mow coastal turf mix.
4. Pollinator mix.
5. Conservation/wildlife mix.

B. Related Requirements:

1. Section 017419 "Construction and Demolition Waste Management and Disposal".
2. Section 018113 "Sustainable Design Requirements."
3. Section 329115 "Soil Preparation (Performance Specification)" for planting soils.
4. Section 32 93 00 "Plants" for trees, shrubs, ground covers, and other plants as well as border edgings and maintenance strips.

1.3 DEFINITIONS

- A. Finish Grade: Elevation of finished surface of planting soil.
- B. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- C. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- D. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329115 "Soil Preparation (Performance Specification)" and drawing designations for planting soils.

- E. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

#### 1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.5 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

#### 1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer.
- B. Certification of Grass Seed: From seed vendor for each grass-seed monostand or mixture, stating the botanical and common name, percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
- C. Product Certificates: For fertilizers, from manufacturer.
- D. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.

#### 1.7 ACTION SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.

#### 1.8 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of turf and meadows during a calendar year. Submit before expiration of required maintenance periods.



## 1.9 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful turf and meadow establishment.
  - 1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
  - 2. Experience: Five years' experience in turf installation in addition to requirements in Section 014000 "Quality Requirements."
  - 3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  - 4. Personnel Certifications: Installer's field supervisor shall have certification in one of the following categories from the National Association of Landscape Professionals:
    - a. Landscape Industry Certified Technician - Exterior.
    - b. Landscape Industry Certified Lawn Care Manager.
    - c. Landscape Industry Certified Lawn Care Technician.
  - 5. Pesticide Applicator: State licensed, commercial.

## 1.10 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.
- B. Bulk Materials:
  - 1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  - 2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  - 3. Accompany each delivery of bulk materials with appropriate certificates.

## 1.11 FIELD CONDITIONS

- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with initial maintenance periods to provide required maintenance from date of Substantial Completion.
  - 1. Spring Planting: April 1 to June 1.
  - 2. Fall Planting: August 15 to October 1.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions.

## 1.12 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace areas of turf that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Unsatisfactory Seeded Turf: unhealthy, non-uniform, loose stand of grass with weeds and surface irregularities, with coverage of less than 90 percent over any 0.92 sq. m (10 sq. ft.) and bare spots exceeding 125 by 125 mm (5 by 5 inches).
  - 2. Warranty Period:
    - a. Satisfactory No Mow/Low Mow Coastal Turf Mix area: 24 months.
    - b. Satisfactory Pollinator mix area: 24 months.
    - c. Satisfactory Conservation/wildlife mix area: 24 months.

## PART 2 - PRODUCTS

### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

### 2.2 NO MOW/LOW MOW COASTAL TURF MIX.

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
  - 1. Quality: State-certified seed of grass species as listed below for solar exposure.
  - 2. Quality: Seed of grass species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
  - 3. Proportioned by weight as follows:
    - a. 30 percent Viking H2O hard fescue.
    - b. 30 percent ambrose chewing fescue.
    - c. 30 percent epic creeping red fescue.
    - d. 10 percent rogue intermediate ryegrass.

### 2.3 POLLINATOR MIX

- A. Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
  - 1. Quality: Seed of selected native grasses and wildflower species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
  - 2. Species to be included as follows:
    - a. Hairy beardtongue
    - b. Sun drops

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- c. Butterfly milkweed
  - d. Round seeded panic grass (low % amount)
  - e. Blue gramma
  - f. Partridge pea
  - g. Little bluestem
  - h. Canada wild rye
  - i. VA/OH spiderwort
  - j. Purple coneflower
  - k. Evening primrose
  - l. Columbine

#### 2.4 CONSERVATION/WILDLIFE MIX

- A. Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
  - 1. Quality: Seed of selected native grasses and wildflower species as listed below for solar exposure, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
  - 2. Species to be included as follows:
    - a. Indian grass
    - b. Virginia wild rye
    - c. Big bluestem (low % amount)
    - d. Canada wild rye
    - e. Switch grass
    - f. Deer tongue
    - g. Little bluestem
    - h. Partridge pea
    - i. Purple coneflower
    - j. Oxeye sunflower
    - k. White snakeroot
    - l. Wild senna
    - m. Blue false indigo
    - n. Orange coneflower
    - o. Zigzag aster
    - p. Golden alexander
    - q. Tall beard tongue
    - r. Smoot blue aster
    - s. Lance leaf coreopsis
    - t. Common milkweed
    - u. Black-eyed Susan
    - v. Wild bergamot
    - w. New England aster white avens
    - x. Blazing star
    - y. Early goldenrod (low % amount)
    - z. Joe pye weed

## 2.5 FERTILIZERS

- A. Do not use fertilizers on areas to receive No-Mow/Low Mow Coastal Turf mix, pollinator mix or conservation/wildlife mix.

## 2.6 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Fiber Mulch: Biodegradable, dyed-wood, cellulose-fiber mulch; nontoxic and free of plant-growth or germination inhibitors; with a maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.
- C. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application; nontoxic and free of plant-growth or germination inhibitors.

## 2.7 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.
- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas to be planted for compliance with requirements and other conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 3. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

- C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

### 3.2 PREPARATION

- A. Protect structures; utilities; sidewalks; pavements; and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
  - 1. Protect adjacent and adjoining areas from hydroseeding and hydromulching overspray.
  - 2. Protect grade stakes set by others until directed to remove them.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

### 3.3 SEEDED AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329115 "Soil Preparation (Performance Specification)."
- B. Placing Planting Soil: Place and mix planting soil in place over exposed subgrade.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.4 SEEDING

- A. Seeding may be applied through either mechanical or hydroseeding methods as indicated below.
- B. Do not include fertilizer in areas to receive Native Grasses and Wildflowers Mix.
- C. Follow application rates and methods as recommended by the seed mix manufacturer.

### 3.5 MECHANICAL SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 8 km/h (5 mph).
  - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate as recommended by the seed distributor.
- C. Rake seed lightly into top 3 mm (1/8 inch) of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes exceeding 1:4 with erosion-control blankets stapled according to manufacturer's written instructions.

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- E. Protect seeded areas with erosion-control mats where indicated on Drawings; install and anchor according to manufacturer's written instructions.
  - F. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 42 kg/92.9 sq. m (2 tons/acre) to form a continuous blanket 38 mm (1-1/2 inches) in loose thickness over seeded areas. Spread by hand, blower, or other suitable equipment.
    - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

### 3.6 HYDROSEEDING

- A. Hydroseeding: Mix specified seed, commercial fertilizer (seeded lawn only), and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogeneous slurry suitable for hydraulic application.
  - 1. Mix slurry with nonasphaltic fiber-mulch manufacturer's recommended tackifier.
  - 2. Spray-apply slurry uniformly to all areas to be seeded in a one-step process. Apply slurry at a rate so that mulch component is deposited at not less than 15.6-kg/92.9 sq. m (1500-lb/acre) dry weight, and seed component is deposited at not less than the specified seed-sowing rate.

### 3.7 STEEP SLOPES:

- A. Slopes with grades 3:1 or steeper after receiving topsoil and seeding shall receive erosion control blanket. See Section 312500.

### 3.8 NO MOW/LOW MOW COASTAL TURF MIX MAINTENANCE

- A. General: Maintain and establish turf by watering, weeding, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
  - 1. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace materials and turf damaged or lost in areas of subsidence.
  - 2. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 3. Apply treatments as required to keep turf and soil free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and turf-watering equipment to convey water from sources and to keep turf uniformly moist to a depth of 4 inches (100 mm).
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water with fine spray at a minimum rate of 1/2 inch per week for six weeks after planting unless rainfall precipitation is adequate.

3.9 SATISFACTORY SEEDED NO MOW/LOW MOW COASTAL TURF MIX

- A. Turf installations shall meet the following criteria as determined by Architect:
  - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

3.10 POLLINATOR MIX AND CONSERVATION/WILDLIFE MIX MAINTENANCE

- A. Maintain and establish Pollinator and Conservation/Wildlife mix areas by watering, weeding, replanting, and performing other operations as required to establish a healthy, viable area. Roll, regrade, and replant bare or eroded areas and remulch. Provide materials and installation the same as those used in the original installation.
  - 1. In areas where mulch has been disturbed by wind or maintenance operations, add new mulch and anchor as required to prevent displacement.
  - 2. Apply treatments as required to keep Native Grass and Wildflower mix areas free of pests and pathogens or disease. Use integrated pest management practices whenever possible to minimize the use of pesticides and reduce hazards.
- B. Watering: Install and maintain temporary piping, hoses, and watering equipment to convey water from sources and to keep area uniformly moist.
  - 1. Schedule watering to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly planted areas.
  - 2. Water with fine spray at a minimum rate of 1/2 inch per week for six weeks after planting unless rainfall precipitation is adequate.

3.11 CLEANUP AND PROTECTION

- A. Promptly remove soil and debris created by turf work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material, including excess subsoil, unsuitable soil, trash, and debris, and legally dispose of them off Owner's property.
- C. Erect temporary fencing or barricades and warning signs as required to protect newly planted areas from traffic. Maintain fencing and barricades throughout initial maintenance period and remove after plantings are established.
- D. Remove nondegradable erosion-control measures after grass establishment period.

3.12 MAINTENANCE SERVICE

- A. Seeded No Mow/Low Mow Coastal Turf Mix Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in " No Mow/Low Mow Coastal Turf Mix Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable turf is established, but for not less than the following periods:
  - 1. Seeded No Mow/Low Mow Coastal Turf Mix: Twenty-four (24) months from date of Substantial Completion.
    - a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.
  
- B. Pollinator and Conservation/Wildlife Mix Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in " Pollinator and Conservation/Wildlife Mix Maintenance" Article. Begin maintenance immediately after each area is planted and continue until acceptable meadow is established, but for not less than maintenance period below.
  - 1. Pollinator and Conservation/Wildlife Mix: Twenty-four (24) months from date of Substantial Completion.
  - 2. When initial maintenance period has not elapsed before end of planting season, or if area is not fully established, continue maintenance during next planting season.

END OF SECTION 329200



## SECTION 329300 - PLANTS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

#### 1.2 SUMMARY

- A. Section Includes:

1. Plants.
2. Tree stabilization.
3. Tree-watering devices.
4. River jack stone aggregate.
5. Landscape edgings.

- B. Related Requirements:

1. Section 015639 "Temporary Tree and Plant Protection" for protecting, trimming, pruning, repairing, and replacing existing trees to remain that interfere with, or are affected by, execution of the Work.
2. Section 017419 "Construction and Demolition Waste Management and Disposal".
3. Section 018113 "Sustainable Design Requirements."
4. Section 329115 "Soil Preparation (Performance Specification)" for planting soil.
5. Section 329200 "Turf and Grasses" for turf (lawn) and meadow planting, hydroseeding, and erosion-control materials.

#### 1.3 DEFINITIONS

- A. Backfill: The earth used to replace or the act of replacing earth in an excavation.
- B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with a ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.
- C. Central Leader: A continuation of the main trunk located more or less in the center of the crown, beginning at the lowest main branch (scaffold) and extending to the top of the tree. Also referred to as the Dominant Leader.
- D. Codominant: Two or more vigorous, upright branches or stems of relatively equal size that originate from a common point, usually where the leader was lost or removed.

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- E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.
  - F. Crown: The portion of a tree beginning at the lowest main (scaffold) branch extending to the top of the tree.
  - G. Finish Grade: Elevation of finished surface of planting soil.
  - H. Included Bark: Bark embedded in the union between a branch and the trunk or between two or more stems that prevents the formation of a normal branch bark ridge.
  - I. Nursery: A place where young trees and plants are grown commercially for sale. Not included in this definition are horticultural distribution centers and plant re-wholesalers.
  - J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. Pesticides include insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. They also include substances or mixtures intended for use as a plant regulator, defoliant, or desiccant. Some sources classify herbicides separately from pesticides.
  - K. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. Pests include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
  - L. Planting Area: Areas to be planted.
  - M. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth. See Section 329115 "Soil Preparation (Performance Specification)" for drawing designations for planting soils.
  - N. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.
  - O. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.
  - P. Scaffold Branches: Large main branches that form the main structure of the crown.
  - Q. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.
  - R. Subgrade: The surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.
  - S. Insert other definitions if required to support planting requirements indicated on Drawings.
  - T. Trunk: The main stem of a tree, beginning at the root collar and ending at the lowest main scaffold branch.

#### 1.4 REFERENCE STANDARDS

- A. American Nursery and Landscape Association (ANLA). Ph: (202) 789-2900. Internet: [www.anla.org](http://www.anla.org).
  - 1. ANSI Z60.1: American Standard for Nursery Stock (2014).

#### 1.5 COORDINATION

- A. Coordination with Architect's Site Visits: The Architect may elect to be present to observe the execution of the following work. Provide not less than 2 full working days advance notice prior to performing these activities. It will be assumed that any work performed without notifying the Architect of the date and time in advance was performed incompletely or incorrectly.
  - 1. Deliveries of plant materials.
  - 2. Layout of plant locations.
  - 3. Preparation of planting area subgrades and placement of planting soil.
  - 4. Installation of plants.
  - 5. Application of pre-emergent herbicide upon completion of spring planting.
- B. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.
  - 1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

#### 1.6 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

#### 1.7 SUSTAINABLE DESIGN REQUIREMENTS

- A. Sustainable Design Requirements: The Owner requires the Contractor to implement practices and procedures to meet the Project's environmental performance goals, which include achieving LEED v4 Certification and demonstrating compliance with the State of Connecticut's High Performance Building Standards. Refer to Section 018113 - SUSTAINABLE DESIGN REQUIREMENTS for the Project's target certification level and specific LEED requirements. The Contractor shall ensure that the requirements related to the Project's sustainability design goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the Project's sustainability goals and LEED certification.

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## 1.8 ACTION SUBMITTALS

- A. LEED v4 Submittals: For all permanently installed products and materials related to the work of this Section, submit product and material documentation to comply with and contribute to the Project's LEED requirements, as outlined in the Submittals article of Section 018113 – Sustainable Design Requirements.
- B. Nursery Source Tagging Submittals
1. Nursery Sources: Within 30-days of the Contract start, submit a list of all proposed nursery sources for approval, confirming the availability of plant varieties, sizes, forms, and quantities indicated in the Contract Documents. For field-grown trees and plants specified as “balled and burlapped”, include photographs of the available plant blocks to confirm that the nurseries have a sufficient selection of satisfactory plants available for tagging. Provide the names and telephone numbers for the nurseries' representatives.
    - a. Substitutions: Substitutions of plant materials will not be permitted unless approved in writing by the Architect. If any of the specified plants are not available at the time when needed to meet the project schedule, submit a statement documenting the nursery sources investigated and providing proposals for equivalent plants of the nearest available size or similar variety. Substitutions will not be allowed if the Architect identifies alternate nursery sources within a 600 mile radius of the project site.
    - b. Container-grown plants shall not be substituted for plants designated “B&B” on the Plant List, unless approved in writing by the Architect.
    - c. Quantities: Quantities shown on the Plant List are for information only. Provide every plant shown on the Drawings. In the event of a discrepancy between the Planting Plans and the written quantities on the Plant List, the Planting Plan shall govern.
  2. Planting Schedule: Submit the projected planting schedule, including nursery visits, digging, delivery, storage, and installation dates to the Architect for review and approval. Schedule the dates for each type of landscape work during normal seasons for such work in each area of the site. Correlate with specified maintenance periods to provide maintenance until conclusion of the planting establishment and maintenance period. Revise schedule to keep current, subject to the Architect's approval.
- C. Product Data: For each type of product.
1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.
  2. Plant Photographs: Include color photographs in digital format of each required species and size of plant material as it will be furnished to Project. Take photographs from multiple angles depicting true size and condition of the typical plant to be furnished. Include a scale rod or other measuring device in each photograph. For species where more than 10 plants are required, include a minimum of three photographs showing the average plant, the best quality plant, and the worst quality plant to be furnished. Identify each photograph with the full scientific name of the plant, plant size, and name of the growing nursery.

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- a. Field-grown trees and shrubs:
    - 1) Specimen trees: Three photographs of every individual specimen tree, taken from multiple angles.
    - 2) Trees and shrubs to be furnished in quantities of 10 or less: At least three photographs of a typical plant taken from multiple angles, plus photos showing overall views of the blocks from which the trees are to be obtained.
    - 3) Trees and shrubs to be furnished in quantities greater than 10: Photographs of the average plant, the best quality plant, and the worst quality plant, plus photos showing overall views of the blocks from which the trees are to be obtained.
  - b. Container-grown trees: Three photographs of each individual tree.
  - c. Container-grown shrubs and vines: One photograph of one typical plant.
  - d. Perennials and grasses: Photographs are not required.
- D. Samples for Verification: For each of the following:
- 1. Organic Mulch: 1-quart volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
  - 2. Slow-Release, Tree-Watering Device: One unit of each size required.
  - 3. River jack stone aggregate: 2 gallon volume of river jack stone aggregate, representing the full range of size, shape and color to be found in the materials proposed for the project.
  - 4. Edging Materials and Accessories: Manufacturer's standard size, to verify color selected.

## 1.9 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For landscape Installer. Include list of similar projects completed by Installer demonstrating Installer's capabilities and experience. Include project names, addresses, and year completed, and include names and addresses of owners' contact persons.
- B. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:
  - 1. Manufacturer's certified analysis of standard products.
  - 2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.
- C. Pesticides and Herbicides: Product label and manufacturer's application instructions specific to Project.
- D. Sample Warranty: For special warranty.

#### 1.10 CLOSEOUT SUBMITTALS

- A. Maintenance Data: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before expiration of required maintenance periods.

#### 1.11 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape installer whose work has resulted in successful establishment of plants.
1. Professional Membership: Installer shall be a member in good standing of either the National Association of Landscape Professionals or AmericanHort.
  2. Experience: Five years' experience in landscape installation in addition to requirements in Section 014000 "Quality Requirements."
  3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.
  4. Personnel Certifications: Installer's field supervisor and personnel assigned to the Work shall have certification in one of the following categories from the National Association of Landscape Professionals:
    - a. Landscape Industry Certified Technician - Exterior.
    - b. Landscape Industry Certified Horticultural Technician.
  5. Pesticide Applicator: State licensed, commercial.
- B. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.
1. Selection of plants purchased under allowances is made by Architect, who tags plants at their place of growth before they are prepared for transplanting.
- C. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.
1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container-grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
  2. Other Plants: Measure with stems, petioles, and foliage in their normal position.
- D. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect may also observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and may reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

#### 1.12 DELIVERY, STORAGE, AND HANDLING

- A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws if applicable.
- B. Bulk Materials:
  1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
  2. Provide erosion-control measures to prevent erosion or displacement of bulk materials; discharge of soil-bearing water runoff; and airborne dust reaching adjacent properties, water conveyance systems, or walkways.
  3. Accompany each delivery of bulk materials with appropriate certificates.
- C. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.
- D. Handle planting stock by root ball.
- E. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.
- F. Apply antidesiccant to trees and shrubs using power spray to provide an adequate film over trunks (before wrapping), branches, stems, twigs, and foliage to protect during digging, handling, and transportation.
  1. If deciduous trees or shrubs are moved in full leaf, spray with antidesiccant at nursery before moving and again two weeks after planting.
- G. Wrap trees and shrubs with burlap fabric over trunks, branches, stems, twigs, and foliage to protect from wind and other damage during digging, handling, and transportation.
- H. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.
  1. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
  2. Do not remove container-grown stock from containers before time of planting.
  3. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly wet condition.



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### 1.13 FIELD CONDITIONS

- A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.
- A. Planting Restrictions: Plant during one of the following periods. Coordinate planting periods with maintenance periods to provide required maintenance from date of Preliminary Acceptance. Planting shall progress only under favorable weather conditions and will not be permitted when the ground is frozen or excessively moist.
1. Plant within the following recommended periods to provide optimal conditions for successful recovery from transplanting stresses:
    - a. Plant deciduous plants: March 1 to May 15, and October 15 until the ground freezes.
      - 1) Spring planting may be extended until June 15 if a well-monitored irrigation system is in use.
    - b. Plant evergreen plants: April 1 to June 1, and August 15 to October 15.
    - c. Perennials and Ornamental Grasses: plant in spring after all danger of frost has passed. Do not plant while ground is still wet or sticky after thawing or heavy from prolonged rain. Complete this work before June 1.
    - d. Bulbs: from September 1 until the ground freezes.
  2. If special conditions exist to justify a variance in the above planting dates, submit a written request to the Architect stating the special conditions and the proposed variance. Describe techniques in addition to those specified herein that will be employed to prevent dieback and mortality. No waiver of the plant guaranty will be granted for planting performed out-of-season.
- B. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.
- C. Watering: The Installer shall bear sole responsibility for the furnishing and application of all irrigation water, irrespective of whether or not an irrigation system is installed or operable. The Installer shall ensure that all irrigation water is applied at the proper frequency, coverage and in the proper amounts to fulfill the plant establishment and maintenance requirements of the Contract. The Installer's responsibility for all watering shall begin upon delivery of plants to the site, and shall continue through the end of the Warranty period.
1. If no irrigation system is available, or if an available irrigation system is unsatisfactory to the Contractor's needs, then the Installer shall furnish and apply all irrigation water.
  2. If an existing irrigation system is made available for the Installer's use, and if the Installer elects to utilize this irrigation system; then the Installer shall accept total responsibility



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for ensuring that the system is satisfactorily adjusted and operated while utilized by the Installer.

3. If an irrigation system is to be provided or design/built under this Contract, and if the Installer elects to utilize this irrigation system; then the Installer shall coordinate with the irrigation designer, installer and operator, and shall accept total responsibility for ensuring that the system is satisfactorily adjusted and operated while utilized by the Installer.

#### 1.14 WARRANTY

- A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.
  1. Failures include, but are not limited to, the following:
    - a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner.
    - b. Structural failures including plantings falling or blowing over.
    - c. Faulty performance of tree stabilization or edgings.
    - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  2. Warranty Periods: From date of Substantial Completion.
    - a. Trees, Shrubs, Vines, and Ornamental Grasses: 24 months.
    - b. Ground Covers, Biennials, Perennials, and Other Plants: 24 months.
  3. Include the following remedial actions as a minimum:
    - a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
    - b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
    - c. Provide extended warranty for period equal to original warranty period, for replaced plant material.

### PART 2 - PRODUCTS

#### 2.1 LEED PERFORMANCE REQUIREMENTS

- A. For all permanently installed products and materials related to the work of this Section, provide products and materials that meet the Project's LEED performance criteria as outlined in PART 2-PRODUCTS of Section 018113 – Sustainable Design Requirements.

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## 2.2 PLANT MATERIAL

- A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant List, Plant Schedule, or Plant Legend indicated on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.
1. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots are unacceptable.
  2. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.
  3. Plants shall have been grown under climatic conditions similar to those of the project site.
  4. Balled and burlapped plants shall be moved as solid units having firm natural balls of soil of sufficient size to encompass the fibrous and feeding root system to ensure full and prompt plant recovery. Plants with loose, manufactured, cracked, broken, or undersized balls will be rejected.
- B. Form and Structure: Unless indicated otherwise in Plant List shown on Drawings, deciduous and evergreen trees shall comply with the following:
1. Habit of growth shall be typical of the species or variety, heavy, symmetrical, well branched and proportioned, and densely foliated when in leaf.
  2. Trees shall have a single, relatively straight vertical trunk and central leader. Deciduous shade trees shall be free of major branches up to a height of at least 6-feet unless otherwise specified. Evergreen and clump-form trees shall have dense, compact growth branched to the ground unless otherwise specified.
  3. Trees shall be free of codominant stems and vigorous, upright branches that compete with the central leader. If the original leader has been headed, a new leader at least one-half of the diameter of the original leader shall be present.
  4. Main branches shall be well-distributed along the central leader, and not clustered together. They shall form a balanced crown appropriate for the cultivar/species.
  5. Branch diameter shall be no larger than two-thirds (one-half is preferred) the diameter of the central leader measured 1 inch above the branch.
  6. The attachment of the largest branches (scaffold branches) shall be free of included bark.
- C. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.
- D. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which begins at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

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- E. Labeling: Label each plant of each variety, size, and caliper with a securely attached, waterproof tag bearing legible designation of common name and full scientific name, including genus and species. Include nomenclature for hybrid, variety, or cultivar, if applicable for the plant.
  - F. If formal arrangements or consecutive order of plants is indicated on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

### 2.3 FERTILIZERS

- A. Planting Tablets: Tightly compressed chip-type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.
  - 1. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

### 2.4 MULCHES

- A. Organic Mulch: Free from deleterious materials and suitable as a top dressing of trees and shrubs, consisting of one of the following:
  - 1. Type: Double-shredded softwood bark composed primarily of pine and spruce bark, un-dyed and aged not less than 9 months. Clean and free of foreign matter and disease. Sample to be approved.
  - 2. Color: natural, un-dyed.

### 2.5 RIVER JACK STONE AGGREGATE

- A. River Jack Stones:
  - 1. Size: 1" – 3"
  - 2. Style: Smooth water washed river stone.
  - 3. Coloration: multi-colored stone consisting of grays, beige, burgundy and browns.

### 2.6 PESTICIDES

- A. General: Pesticide registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.
- B. Pre-Emergent Herbicide (Selective and Nonselective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

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- C. Post-Emergent Herbicide (Selective and Nonselective): Effective for controlling weed growth that has already germinated.

## 2.7 TREE-STABILIZATION MATERIALS

### A. Trunk-Stabilization Materials:

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal by length indicated, pointed at one end.
2. Guys and Tie Wires: ASTM A641/A641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch (2.7 mm) in diameter.
3. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.

## 2.8 LANDSCAPE EDGINGS

### A. Steel Edging: Standard commercial-steel edging, fabricated in sections of standard lengths, with loops stamped from or welded to face of sections to receive stakes.

1. Edging Size: 1/4 inch thick by 5 inches deep.
2. Stakes: Tapered steel, a minimum of 15 inches long.
3. Accessories: Standard tapered ends, corners, and splicers.
4. Finish: Hot dip galvanized steel.

### B. Subject to compliance with requirements, provide above product by one of the below listed manufacturers.

1. Sure-Loc, Holland, MI (800) 787-3562, [www.surelocedging.com](http://www.surelocedging.com)
2. Border Concepts, Charlotte, NC (704) 541-5509, [www.borderconcepts.com](http://www.borderconcepts.com)
3. JD Russell Company, Shelby Township, MI (800) 888-9708, [www.jdrussellco.com](http://www.jdrussellco.com)

## 2.9 TREE-WATERING DEVICES

### A. Slow-Release Watering Device: Standard product manufactured for drip irrigation of plants and emptying its water contents over an extended time period; manufactured from UV-light-stabilized nylon-reinforced polyethylene sheet, PVC, or HDPE plastic.

1. Color: green.

## 2.10 MISCELLANEOUS PRODUCTS

### A. Wood Pressure-Preservative Treatment: AWWPA U1, Use Category UC4a; acceptable to authorities having jurisdiction, and containing no arsenic or chromium.

### B. Antidesiccant: Water-insoluble emulsion, permeable moisture retarder, film forming, for trees and shrubs. Deliver in original, sealed, and fully labeled containers and mix according to manufacturer's written instructions.

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- C. Burlap: Non-synthetic, biodegradable.
  - D. Mycorrhizal Fungi: Dry, granular inoculant containing at least 5300 spores per lb (0.45 kg) of vesicular-arbuscular mycorrhizal fungi and 95 million spores per lb (0.45 kg) of ectomycorrhizal fungi, 33 percent hydrogel, and a maximum of 5.5 percent inert material.
  - E. Free-Draining Material: Sand, gravel, stone or mixtures thereof, with not more than 70 percent by weight passing the No. 40 mesh sieve and not more than 10 percent by weight passing the No. 200 sieve.
  - F. Deer Repellant: Commercial product with documented deer-deterrent properties.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Examine areas to receive plants, with Installer present, for compliance with requirements and conditions affecting installation and performance of the Work.
  - 1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
  - 2. Verify that plants and vehicles loaded with plants can travel to planting locations with adequate overhead clearance.
  - 3. Suspend planting operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
  - 4. Uniformly moisten excessively dry soil that is not workable or which is dusty.
- B. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.
- B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.
- C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

1. Plant locations on the Drawings are approximate and are to be used only as a guide. Installer shall accurately stakeout plant locations and bed outlines. Do not begin planting excavations until the Architect has approved or adjusted the stakeouts. Prior to installation, modify plant locations within the project site as directed by the Architect without additional cost to the Owner.
2. Unless otherwise indicated, massed plantings and rows of shrubs, perennials, and grasses are to be installed in a staggered triangular or diagonal configuration. Straight, square rows will not be accepted.

### 3.3 PLANTING AREA ESTABLISHMENT

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329115 "Soil Preparation (Performance Specification)."
- B. Placing Planting Soil: Place prepared planting soil over exposed subgrade .
- C. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.
- D. Application of Mycorrhizal Fungi: At time directed by Architect, broadcast dry product uniformly over prepared soil at application rate according to manufacturer's written recommendations.

### 3.4 EXCAVATION FOR TREES AND SHRUBS

- A. Planting Pits and Trenches: Excavate circular planting pits.
  1. Excavate planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are unacceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.
  2. Excavate approximately three times as wide as ball diameter for stock.
  3. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
  4. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
  5. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
  6. Maintain angles of repose of adjacent materials to ensure stability. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
  7. Maintain supervision of excavations during working hours.
  8. Keep excavations covered or otherwise protected when unattended by Installer's personnel.
  9. If drain tile is indicated on Drawings or required under planting areas, excavate to top of porous backfill over tile.

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- B. Continuous Planting Beds for Shrubs:
1. Excavate shrub beds to a minimum depth of 18" with sides sloping inward at a 45-degree angle. Loosen subgrade by dragging with teeth of bucket 3" to 6" deep. Install first lift of planting soil immediately and do not allow loosened subgrade to become compacted.
  2. Install planting soil in 2 equal lifts. Compact each lift to a minimum of 75% and a maximum of 82% of Standard Proctor Density. Scarify between lifts by dragging with the teeth of bucket.
  3. Excavate circular planting pits in continuous beds after the planting soil has been installed in continuous beds.
- C. Backfill Soil: Subsoil and topsoil removed from excavations may not be used as backfill soil unless otherwise indicated.
- D. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.
1. Hardpan Layer: Drill 6-inch- (150-mm-) diameter holes, 24 inches (600 mm) apart, into free-draining strata or to a depth of 10 feet (3 m), whichever is less, and backfill with free-draining material.
- E. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.
- F. Fill excavations with water and allow to percolate away before positioning trees and shrubs.

### 3.5 TREE, SHRUB, AND VINE PLANTING

- A. Inspection: At time of planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.
- B. Roots: Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.
- C. Balled and Burlapped Stock: Set each plant plumb and in center of planting pit or trench with root flare 3 inches above adjacent finish grades.
1. Backfill: Planting soil Type I or Type II.
  2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
  3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.



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4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
    - a. Quantity: According to manufacturer's written recommendations.
  5. Continue backfilling process. Water again after placing and tamping final layer of soil.
- D. Container-Grown Stock: Set each plant plumb and in center of planting pit or trench with root flare 3 inches above adjacent finish grades.
1. Backfill: Planting soil Type I or II.
  2. Carefully remove root ball from container without damaging root ball or plant.
  3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
  4. Place planting tablets equally distributed around each planting pit when pit is approximately one-half filled. Place tablets beside the root ball about 25 mm (1 inch) from root tips; do not place tablets in bottom of the hole.
    - a. Quantity: According to manufacturer's written recommendations.
  5. Continue backfilling process. Water again after placing and tamping final layer of soil.
  6. Apply pre-emergent herbicide to spring-planted plants after soil has settled by packing and irrigation or rainfall, in accordance with the manufacturer's written instructions.
- E. Slopes: When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

### 3.6 TREE, SHRUB, AND VINE PRUNING

- A. Remove only dead, dying, or broken branches. Do not prune for shape.
- B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.
- C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.
- D. Do not apply pruning paint to wounds.

### 3.7 TREE STABILIZATION

- A. Trunk Stabilization by Upright Staking and Tying: Install trunk stabilization as follows unless otherwise indicated on Drawings:



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1. Upright Staking and Tying: Stake trees of 2- up 5-inch caliper. Use a minimum length required to penetrate at least 12 inches below bottom of backfilled excavation and to extend to the dimension indicated on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.
  2. Support trees with two strands of tie wire, connected to the brass grommets of tree-tie webbing at contact points with tree trunk. Allow enough slack to avoid rigid restraint of tree.
    - a. Attach flags to each guy wire, 30 inches above finish grade.
  - B. Trunk Stabilization by Staking and Guying: Install trunk stabilization as follows unless otherwise indicated on Drawings.
    1. Proprietary Staking and Guying Device: Install staking and guying system sized and positioned as recommended by manufacturer unless otherwise indicated and according to manufacturer's written instructions.

### 3.8 GROUND COVER AND PLANT PLANTING

- A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on Drawings in even rows with triangular spacing.
- B. Use planting soil Type I or II for backfill.
- C. Dig holes large enough to allow spreading of roots.
- D. For rooted cutting plants supplied in flats, plant each in a manner that minimally disturbs the root system but to a depth not less than two nodes.
- E. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.
- F. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.
- G. Apply preemergent herbicide to spring-planted plants after soil has settled by packing and irrigation or rainfall, in accordance with the manufacturer's written instructions.
- H. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

### 3.9 PLANTING AREA MULCHING

- A. Mulch backfilled surfaces of planting areas and other areas indicated.
  1. Trees and Treelike Shrubs in Turf Areas: Apply organic mulch ring of 3-inch average thickness, with 36-inch radius around trunks or stems. Do not place mulch within 6 inches of trunks or stems.
  2. Organic Mulch in Planting Areas: Apply 2-inch average thickness of organic mulch extending 12 inches beyond edge of individual planting pit or trench and over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches of trunks or stems.

### 3.10 INSTALLATION OF EDGING

- A. Steel Edging: Install steel edging where indicated according to manufacturer's written instructions. Anchor with steel stakes spaced approximately 30 inches apart, driven below top elevation of edging.

### 3.11 RIVER JACK STONE SURFACING

- A. Excavate for stone surfacing to the grades indicated in the Drawings.
- B. Compact subgrade uniformly.
- C. Apply nonselective, pre-emergent herbicide that inhibits growth of grass and weeds.
- D. Install geotextile fabric as indicated in the Drawings.
- E. Install steel edging, delineating the edge of the stone pavement area, unless abutted by curbs or walls.
- F. Place river jack stone as indicated in the Drawings.

### 3.12 INSTALLATION OF SLOW-RELEASE WATERING DEVICE

- A. Provide one device for each tree.
- B. Place device on top of the mulch at base of tree stem and fill with water according to manufacturer's written instructions.

### 3.13 PLANT MAINTENANCE

- A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings.
- B. Fill in, as necessary, soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.
- C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated pest management practices when possible to minimize use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.
- D. Heavily water woody plants in late fall, after leaf drop and before the ground freezes.
- E. Apply pre-emergent herbicide to planted areas in early spring when the average soil temperature reaches 52 degrees F at one-half inch soil depth. If treatment is unsuccessful and weeds germinate, provide additional pre-emergent treatment after cultivating soil to remove weeds in late spring.

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- F. Provide early spring clean-up of perennial and ornamental grass beds before new growth starts. Cut back and remove dead top growth, repair damage, remove weeds, refresh mulch, and re-edge beds.
  - G. Protect plants from deer damage, including regularly monitoring deer activity and timely applications of deer repellents and barriers.
  - H. Upon Final Acceptance at end of Maintenance Period, remove tree-stabilization devices and planting saucers. Dress with mulch.

### 3.14 PESTICIDE APPLICATION

- A. Apply pesticides and other chemical products and biological control agents according to authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.
- B. Pre-Emergent Herbicides (Selective and Nonselective): Apply to tree, shrub, and ground-cover areas according to manufacturer's written recommendations. Do not apply to seeded areas.
- C. Post-Emergent Herbicides (Selective and Nonselective): Apply only as necessary to treat already-germinated weeds and according to manufacturer's written recommendations.

### 3.15 REPAIR AND REPLACEMENT

- A. General: Repair or replace existing or new trees and other plants that are damaged by construction operations, in a manner approved by Architect.
  - 1. Submit details of proposed pruning and repairs.
  - 2. Perform repairs of damaged trunks, branches, and roots within 24 hours, if approved.
  - 3. Replace trees and other plants that cannot be repaired and restored to full-growth status, as determined by Architect.
- A. **Remove and replace trees that are more than 25 percent dead or in an unhealthy condition before the end of the corrections period or are damaged during construction operations that Architect determines are incapable of restoring to normal growth pattern.**
  - 1. **Provide new trees of same size as those being replaced for each tree.**
  - 2. **Species of Replacement Trees: Same species being replaced.**

### 3.16 CLEANING AND PROTECTION

- A. During planting, keep adjacent paving and construction clean and work area in an orderly condition. Clean wheels of vehicles before leaving site to avoid tracking soil onto roads, walks, or other paved areas.
- B. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

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- C. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.
  - D. After installation and before Substantial Completion, remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.
    - 1. Do not remove Architect's seals. The Architect will remove the seals during the Final Inspection at the end of the Maintenance Period.
  - E. At time of Substantial Completion, verify that tree-watering devices are in good working order and leave them in place. Replace improperly functioning devices.
  - F. Remove any temporary irrigation systems for plant establishment within 24 months of the start of the Maintenance Period

### 3.17 MAINTENANCE SERVICE

- A. Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: Twenty-four months from date of Planting Acceptance or upon Substantial Completion of the contract, whichever occurs later.
- B. Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in "Plant Maintenance" Article. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established, but for not less than maintenance period below:
  - 1. Maintenance Period: Twenty-four months from date of Planting Acceptance or upon Substantial Completion of the contract, whichever occurs later.
- C. A sum sufficient to cover the cost of possible replacement plants will be held by the Owner until the satisfactory completion of the Maintenance Period.

END OF SECTION 329300

## SECTION 330523 HORIZONTAL DIRECTIONAL DRILLING

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. The plans, profiles, sections, details, and specifications provided are for information only. It the Contractor's responsibility and expense to check, confirm and modify the design to accommodate the Contractor's capacity and equipment. The Contractor shall provide all investigation, planning, calculations, additional geotechnical work if needed, equipment, labor, all other incidentals, and etc. necessary to perform the proposed directional bores, as indicated on drawings, using horizontal directional drilling (directional boring) technology and properly install the pipe as required. Pipe materials shall match those indicated on the plans. Horizontal Directional Drilling construction plans that prepared by the Contractor shall be stamped and sealed by Professional Engineer registered in the State of Connecticut and submitted to the design engineer shop drawings for review and approval.
- B. Coordination with public water utility companies: Connecticut Water Company and Thomaston Water Pollution Control Authority.
- C. The Horizontal Directional Drilling installation is subject to the CT DEEP license for Flood Management Certification and General Permit for Water Resource Construction Activities approval conditions.
  - 1. Storage within the Floodplain. The proposed 100-foot by 200-foot staging area for the directional drilling operations shall not be within the 100-year floodplain of Broad Brook.
  - 2. Drilling Monitoring and Operations. The Licensee shall implement and establish protocols to be taken in the event of an inadvertent return or a bentonite release, or a drilling fluid release into the Branch Brook watershed during directional drilling operations. Such protocols shall be included within the contract specifications and provided to the Commissioner for review and approval prior to commencement of drilling operations. In the event of a bentonite or drilling fluid release to the Branch Brook, a bentonite or fluid containment system shall be installed and maintained in optimal operating condition throughout the duration of the work authorized herein and shall not be removed until after construction has been completed per authorized activity referenced in the Permit, the site has been stabilized, all remediation efforts have been completed, and removal of the containment system has been approved in writing by the Commissioner. Any release shall immediately be reported to the Commissioner.
- D. The Contractor's responsibility includes furnishing, installing, monitoring, and maintaining Erosion and Sedimentation devices, as required by the Construction Documents. After the required work is completed and accepted, it is the Contractor's responsibility to remove the Erosion and Sedimentation devices and dispose of the Site.

- E. The Contractor's responsibility includes clearing and grubbing staging areas, cutting and patching the bituminous pavement, disposing of the debris of the Site, restriping pavement, repairing gravel surfaces, protecting, dismantling, and reinstalling the wooden fence and Jersey barrier, and topsoiling and seeding disturbed lawn on the Black Rock State Park, the CT DEEP Maintenance garage property, 422 Watertown Road, and with CT DOT R.O.W, and Route 6. See the Project specifications, plans, and details for the restoration information.
- F. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

## 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. The CT DEEP license for Flood Management Certification and General Permit for Water Resource Construction Activities approval conditions.
- C. Connecticut Water Company "Rules and Regulations of the Connecticut Water Company As Approved by DPUC on July 14, 2010".
- D. Thomaston Water Pollution Control Authority rules and regulations.
- E. Connecticut Public Health Code Rules and Regulations.
- F. State of Connecticut Department of Transportation "The Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, as amended and merged with the July 2019 supplemental specifications.
- G. The Project is subject to General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities. Part of the General Permit, Stormwater Pollution Control Plan (SWPCP) is prepared and approved by CT DEEP for the Contractor to use.

## 1.3 RELATED SECTIONS

- A. Section 312000 "Earthmoving"
- B. Section 312333 "Trenching and Backfilling" for Excavation, Detectable Warning Tape, and Backfill.
- C. Section 312319 "Dewatering".

- D. Section 315000 "Excavation Support and Protection".
- E. Section 312513 Erosion Controls.
- F. Section 321216 Asphalt Paving.
- G. Section 321313 Concrete Paving.
- H. Section 321613 Precast Concrete Curbing
- I. Section 321723 Pavement Markings
- J. Section 329200 Turf and Grasses
- K. Section 331000 "Exterior Water Utilities".
- L. Section 333000 "Exterior Sanitary Utilities".

#### 1.4 ABBREVIATIONS

- A. PVC: Polyvinyl chloride plastic.
- B. HDPE: High-density polyethylene.

#### 1.5 DEFINITIONS

- A. Horizontal Directional Drilling (HDD): A construction method consisting of drilling a small diameter pilot hole within the designed tolerances for radius requirements, followed by enlargement of the hole to accommodate the product line.
- B. Butt Fusion and Welding: The terms butt-fusion and welding, and derivatives thereof, are to be interpreted synonymously within this Section.

#### 1.6 GENERAL REQUIREMENTS

- A. The Contractor shall assume all responsibility for his methods of construction, the stability and accuracy of the drilled and reamed hole and pits constructed by him, and all costs for damages resulting from any failure thereof and be solely responsible for the safety of the pits and related structures, and personnel engaged in underground construction throughout the duration of the work.

- B. The general dimensions, arrangement, and details for the drilled pilot hole and entry and exit pits to be constructed shall be as indicated on the approved Shop Drawings.
- C. Methods of excavation, equipment, and procedures for the HDD operation and pits shall be selected to provide adequate working space and clearances for the work to be performed.
- D. Utility Protection: Utility lines and structures indicated on the Drawings shall be protected from any damage.
  - 1. All utilities within 10 feet of the drill pilot bore, back ream or utility carrier pipe installation will be exposed through a "pot-hole" or other opening, in accordance with appropriate utility locate laws and regulations, to ensure, through visual inspection, that the drill, reamer or utility carrier pipe has caused no damage to the utility and maintains adequate clearance. All potholes to locate existing utilities shall be sealed with an excavatable grout to avoid a possible flow path for the HDD drilling mud.
  - 2. Prior to commencing drilling operations:
    - a. Contact the utility or utility location/notification service, if appropriate for the construction area.
    - b. Positively locate and stake all existing lines, cables, storm sewers, or other underground facilities, including exposing any facilities which are located within 10 feet of the designed drilled path.
- E. Applicable Regulations and Codes: All work covered by this Section shall be performed in accordance with the applicable local, state, and federal codes and laws that pertain to such work and supplemental regulations that are contained in these Contract Documents.
- F. The size and number of temporary bypass pipes, if required to be installed by HDD shall be determined by the Contractor, as approved by the Engineer, and shall be in accordance with the requirements for capacity.
- G. At all times, when construction is not in progress, watertight plugs shall be installed in all pipe ends and openings, either following aboveground pipe fusing and storage before pipe pulling or following underground installation after pipe pull back.
- H. Install, monitor, and maintain all erosion and sedimentation devices prior to any site or staging area disturbance. That includes but not limited: siltation fence, silt socks, construction entrances, haybales, and silt boom.
- I. Remove and safely store the wooden fence, jersey barrier, and any other obstruction.
- J. Cut bituminous concrete pavement and curbing, and dispose of the Site.
- K. Clear and grub staging area and dispose of the debris of the Site.



1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Contractor shall have a minimum of five (5) years of experience installing the specified process on no fewer than five (5) similar projects that have been in place for more than one year, and shall provide trained laborers with prior experience in the specified process
  
- B. Pre-Installation Meeting:
  - 1. Shall occur before installation of the Horizontal Directional Drilling.
    - a. Shall be attended by the Contractor, General Contractor, Construction Superintendent, Construction Administrator, Owner, and Architect.
    - b. Establish the Project timeline and communicate the necessity of quality assurance measures.
    - c. Review the sequencing and scheduling of the work

1.8 SUBMITTALS

- A. Horizontal Directional Drilling construction plans that prepared by the Contractor shall be stamped and sealed by Professional Engineer registered in the State of Connecticut and submitted to the design engineer as shop drawings for review.
  
- B. Statement of Qualifications and Records.
  
- C. The Contractor shall prepare a schedule for the work and submit it to the Engineer for approval. The schedule shall include all major tasks to be performed, including the following:
  - 1. Pipe delivery.
  - 2. Rig mobilization and setup.
  - 3. Pipe assembly.
  - 4. Pilot hole drilling.
  - 5. Reaming.
  - 6. Testing pipe before installation.
  - 7. Pipe pulling.
  - 8. Testing and pigging pipe after installation.
  
- D. At least 30 days prior to mobilization of equipment, the Contractor shall submit a detailed installation plan to the Engineer for review and approval. The plan shall also include a detailed plan and profile of the bore plotted at a scale no smaller than 1-inch equal 40 feet horizontally and vertically.
  
- E. A detailed description of the directional drilling procedures, including operational sequences.

- F. Details of the guidance or grade and alignment control system.
- G. Working drawings, including the following:
  - 1. Proposed layout of the job.
  - 2. Secondary Containment Plan.
  - 3. Directional drill shop drawings.
  - 4. Hole lubrication details.
  - 5. Soil test data, if additional is required.
- H. Pipe shop drawings showing complete dimensions including length, internal diameter, pressure rating, and wall thickness; detailing; maximum allowable deflection of the pipe; detailing; mechanical connections; and necessary accessories for manufacture, transportation, storage, handling, and installation.
- I. Shop drawings showing all specials fittings, joint restraint systems, adapters, and couplings.
- J. Pipe Assembly Procedures
  - 1. Descriptions of procedures for fabricating, handling, transporting, and storing pipe segments.
  - 2. Calculations of stresses and longitudinal strains developed in the pipe during handling and installation.
  - 3. Description of controls to safeguard that the allowable pulling forces will not be exceeded during the installation.
  - 4. Description of procedures for lifting pipe. The design shall allow for the complete removal of lifting devices once in a position to install.
  - 5. Calculations showing allowable lifting configurations so allowable stresses will not be exceeded.
  - 6. Product data and certification that materials and manufacturing tolerances meet requirements specified in the respective pipe material sections.
  - 7. Description of procedures, methods, and materials that will be used to repair pipe or pipe joints damaged during installation.
  - 8. Description of methods and materials that will be used to correct leaks in pipe or pipe joints.
- K. Drilling Fluids data.
- L. Additives material data.
- M. Tracer Wire data.
- N. Drill Rod Certification.
- O. Fusion Technician Qualifications

- P. The Horizontal Directional Drilling installation is subject to the CT DEEP license for Flood Management Certification and General Permit for Water Resource Construction Activities approval conditions.
  - 1. Drilling Monitoring and Operations. The Licensee shall implement and establish protocols to be taken in the event of an inadvertent return or a bentonite release or a drilling fluid release into the Branch Brook watershed during directional drilling operations. Such protocols shall be included within the contract specifications and provided to the Commissioner for review and approval prior to commencement of drilling operations. In the event of a bentonite or drilling fluid release to the Branch Brook, a bentonite or fluid containment system shall be installed and maintained in optimal operating condition throughout the duration of the work authorized herein and shall not be removed until after construction has been completed per authorized activity referenced in the Permit, the site has been stabilized, all remediation efforts have been completed and removal of the containment system has been approved in writing by the Commissioner. Any release shall immediately be reported to the Commissioner.

#### 1.9 QUALIFICATIONS

- A. Ensure that the field supervisor and workers assigned to this project are experienced in work of this nature and have successfully completed similar projects of similar length, pipe type, pipe size, and soil type using directional drilling in the last three (3) years. As part of the bid submission, submit project descriptions which include, at a minimum, a listing of the location(s), date of project(s), owner, pipe type and material, size installed, length of the installation, manufacturer of equipment used, and other information relevant to the successful completion of the project.

#### 1.10 SAFETY

- A. Include in directional drilling equipment machine safety requirements a common grounding system to prevent electrical shock in the event of an underground electrical cable strike. Ensure the grounding system connects all pieces of interconnecting machinery; the drill, mud mixing system, drill power unit, drill rod trailer, operator's booth, worker grounding mats, and any other interconnected equipment to a common ground. Equip the drill with an "electrical strike" audible and visual warning system that notifies the system operators of an electrical strike.

#### 1.11 HORIZONTAL DIRECTIONAL DRILLING PLAN

- A. Provide a plan prepared, signed, and sealed by a licensed Professional Engineer. Submit supporting calculations, certifications, and material product data demonstrating the strength of the product pipes for acceptance before the beginning of the installation. Demonstrate that the proposed material satisfies the purpose of the utility and withstands the design and construction stresses and pressures. The HDD Plan shall include the following:

1. Layout Plan. Provide a plan location of the operation, including entry and exit points, discussing the relationship of the equipment, pipe assembly, and staging areas.
2. Utility Profile. Provide a profile of the utility plotted at a scale appropriate for the work.
3. Equipment List. Provide a directional drilling equipment list including: drilling rig, drill bit, back-reamer, mud mixing and pumping systems, down-hole tools, guidance system, and rig safety system. Provide calibration records for the guidance system.
4. Drilling Fluid Management Plan. Provide a drilling fluid management plan to include drilling fluid types and specifications, cleaning, and recycling equipment, estimated flow rates, procedures for minimizing drilling fluid escape, and the method/location for final disposal of waste drilling fluids. Provide a frac out control plan, including frac control materials that will be onsite and contact information for emergency personnel.
5. Pedestrian Access. When and where installations disrupt pedestrian use of sidewalk for periods exceeding two consecutive days, provide an alternate route that meets current ADA requirements.
6. Method and Procedures. Provide an outline of the methods and procedures, describing the pilot hole drilling procedure, the reaming operation, and the pullback procedure, including drawings, schedule of operations, specifications, and method of operation. Include pipe storage and handling details and pipeline assembly and installation procedures.
7. Safety Data Sheets. Submit safety data sheets for fluids and additives.
8. Revisions. If site conditions change and require modification to the HDD Plan, submit a revised drilling plan to achieve a successful installation. Explain, in the revised submittal, the anticipated and encountered conditions that mandated the change in plans.
9. Fusion Technician Qualifications. The fusion technician must be qualified by the fusion equipment manufacturer to thermally butt-fuse the size of the pipe used at the time of fusion performance. Each joint must be datalogged, recorded, and submitted for review.

#### 1.12 DELIVERY, STORAGE, AND HANDLING

- A. Transport, store and handle pipe segments so as to avoid damaging the surfaces, protective coatings, edges and corners, and to prevent excessive stresses.
- B. Inspect materials delivered to the Site for damage. All materials found during inspection or during the progress of work to have cracks, flaws, surface abrasions, or other defects will be rejected. Remove defective materials from the job site.
- C. Handle pipe by lifting using nylon slings or other non-metallic contact means. The use of lifting eyelets is not permitted.
- D. Use supports as needed when storing pipe segments to avoid damage. Store pipe in accordance with the manufacturer's written recommendations.

- E. After delivery to the project site, the pipe shall be stored at ambient temperature and protected from ultraviolet light degradation.
- F. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- G. Protect stored piping from moisture and dirt. Elevate the above grade. Do not exceed the structural capacity of the floor when storing inside. Store plastic piping protected from direct sunlight.
- H. Protect flanges, fittings, and specialties from moisture and dirt.

## PART 2 - EQUIPMENT, MATERIALS, AND PRODUCTS

### 2.1 EQUIPMENT

- A. Drill Rod:
  - 1. Select the appropriate drill rod to be used. Submit a certified statement that the drill rod has been inspected and is in satisfactory condition for its intended use.

### 2.2 MATERIALS

- A. Piping and conduits installed by horizontal directional drilling shall be HDPE, or as indicated in the plans and other sections of these specifications.
  - 1. 3-inch. HDPE IPS SDR 7.3:
    - a. Install a 3-inch nominal diameter high-density polyethylene pipe (HDPE) with a standard dimension ratio of 7.3 (SDR7.3). Provide pipe conforming to ASTM D3350, ASTM F714, and AWWA C906. The pipe is green in color
    - b. Use the butt fusion jointing method for plain end HDPE pipe. Comply with AWWA C906 and ASTM F2620 for butt fusion joints.
    - c. The minimum pressure class /SDR rating acceptable shall be 318 psi /SDR 7.3. The Pipe shall be IPS and shall have an interior diameter no less than the pipe that it is connected to.
    - d. Provide special fitting and required restrains for the connection to 3" PVC Sch.80 pipe at the proposed pump station.
    - e. Provide special fitting for the connection and required restrains to the proposed manhole (s) is required.
  - 2. 8-inch. HDPE DIPS SDR 7:

- a. Install an 8-inch nominal diameter high-density polyethylene pipe (HDPE) with a standard dimension ratio of 7 (SDR7). Provide pipe conforming to ASTM D3350, ASTM F714, and AWWA C906. The pipe is green in color
  - b. Use the butt fusion jointing method for plain end HDPE pipe. Comply with AWWA C906 and ASTM F2620 for butt fusion joints.
  - c. The minimum pressure class /SDR rating acceptable shall be 333 psi /SDR 7. The Pipe shall be DIPS and shall have an interior diameter no less than the pipe that it is connected to.
  - d. Provide special fitting and required restrains for the connection to 8" DI pipe at the proposed water main on the Black Rock State Park property in the Town of Watertown.
  - e. Provide special fitting and required restrains for the connection to the proposed meter vault on the CT DEEP Garage property in the Town of Thomaston
3. Pipe and couplings shall be made from unplasticized PVC compounds having a minimum cell classification of 12454\_B, as defined in ASTM D1784. Pipe, couplings, and locking splines shall be completely non-metallic. The compound shall qualify for a Hydrostatic Design Basis (HDB) of 4000 psi for water at 73.4 degrees in F, in accordance with the requirements of ASTM D2837.
4. Pipe shall be joined using non-metallic couplings to form an integral system for maximum reliability and interchangeability. High-strength, flexible thermoplastic splines shall be inserted into mating, precision-machined grooves in the pipe and coupling to provide full 360-degree restraint with evenly distributed loading.
5. Couplings shall be designed for use at or above the rated pressures of the pipe with which they are utilized, and shall incorporate twin elastomeric sealing gaskets meeting the requirements of ASTM F477. Joints shall be designed to meet the leakage test requirements of ASTM D3139.
6. Joints: Joints shall be a heat fusion joining system. Pipe and fittings shall be thermal butt fusion, saddle fusion, or socket fusion in accordance with manufacturer recommended procedures and ASTM D-2161. At the point of fusion, the outside diameter and minimum wall thickness of the fitting shall match the outside diameter and minimum wall thickness specifications of ASTM D-1248 for the same size pipe.
- Joining of the pipes and fittings shall be performed in accordance with ASTM D-2774. Depending upon the installation requirements and site location, joining shall be performed within or outside the excavation. Joints of the pipe sections shall be smooth on the inside and internal projection beads shall not be greater than 3/16 inch.
- The tensile strength at yield of the butt-fusion joints shall not be less than the pipe. A specimen of the pipe cut across the butt-fusion joints shall be tested in accordance with ASTM D-638.
- The manufacturer shall provide fusion training. The contractor and the onsite joint inspector shall be trained by the manufacturer or manufacturer's authorized representative.

7. Fittings: All fittings shall be provided as required to complete this installation. HDPE Fittings shall be of the same material and class as the pipe and shall be manufactured by the manufacturer of the pipe. HDPE Elbows, tees, and wyes shall be manufactured by mitered fabrication. The manufacturer shall have a written specification for all standard mitered fittings, which establishes Quality Control criteria and tolerances. The manufacturer may be required to demonstrate its ability to produce product required by this specification.

Mechanical joint anchor fittings shall be used to transition from HDPE to DI or PVC. The fitting shall be stronger than the pipe in that when it is subjected to tensile stress, the pipe will pull apart before the fitting will pull out and the pipe blow before the fitting will rupture under pressure.

The mechanical joint Adapter shall have a pre-installed stainless-steel stiffener, in accordance with Plastic Pipe Institute (PPI) recommendations, to neutralize point-loading, ACQ, creep and loss of gasket seal due to diameter contraction. The stiffener shall be engineered sufficiently thick to avoid radial buckling due to gasket pressure.

The Mechanical Joint Adapter requires longer bolts and shall be sold with the modified longer bolt kit to avoid construction delays or improper installation with too shorth bolts.

All fittings for forcemain or pressure rated fittings shall be rated according to the manufacturer's written specifications, and clearly labeled on the fitting as such.

8. Installation: The installation shall conform to the requirements of the manufacturer, the AWWA Standard, and as indicated on the plans and specified herein.

9. Marking and Certification: Each length of HDPE sanitary sewer shall be clearly marked with the Manufacturer's Name, Tradename or Trademark, Nominal pipe size, Pipe Stiffness, Production Code/Extrusion Code, Material Cell Class Designation and ASTM number.

The pipe manufacturer shall provide certification that the stress regression testing has been performed on the specific product. The said certification shall include a stress live curve per ASTM D-2837. The stress regression testing shall have been performed in accordance with ASTM D-2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis of 1,600 psi as determined by ASTM D-2837. This certification shall also state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used and its source.

B. Drilling Fluids:

1. Use a high-quality bentonite drilling fluid to ensure hole stability, cuttings transport, bit and electronics cooling, and hole lubrication to reduce drag on the drill pipe and the product pipe. Use only fluid with a composition which complies with all Federal, State, and local environmental regulations.

C. Additives:

1. Use admixtures as required to address soil conditions and water conditions such as water hardness, acidity, and alkalinity.
- D. Tracer Wire:
1. Use a continuous sheathed solid conductor copper wireline, minimum #12 AWG. Sheathing shall be color-coded to match the utility.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Refer to Division 31 Section 312000 "Earthmoving".
- B. Refer to Division 31 Section 312333 "Trenching and Backfilling" for Excavation, Detectable Warning Tape, and Backfill.

#### 3.2 EXAMINATION

- A. Additional Soil Test Data, if required.
  1. Provide written documentation of conformance with AASHTO T 180.

#### 3.3 INSTALLATION

- A. Depths of all existing utilities must be confirmed by the Contractor prior to the crossing to avoid conflicts. Equipment shall be utilized that does not require the conventional bore and receiving pits due to space constraints. Proper connection to the piping at each end shall be done by standard excavation. The Contractor shall be responsible to provide a slurry containment pit and shall remove all excess material and dispose of appropriately off-site upon completion. All erosion control facilities shall be provided to contain any solids from migrating beyond the project site. The Contractor shall be required to provide the necessary water.
- B. In all cases, the manufacturer's recommendations and procedures shall be followed regarding the installation of their pipe material by horizontal directional drilling.
- C. The subsurface investigation, if deemed necessary, shall be provided by the Contractor prior to installation. No additional payments will be made if a rock is encountered or if soil conditions required additional construction time and equipment. Proper equipment and methods shall be used in rock and soil bores to insure proper grades, elevations, and separations.



- D. The requirements of all applicable local and state authorities shall be followed by the Contractor.
- E. The piping shall be installed at the minimum depths indicated in the plans and shall deviate no more than six (6) inches along the vertical axis and tow (2) feet along the horizontal alignment.
- F. The contractor must notify "CALL BEFORE YOU DIG" (1-800-922-4455 or "811") prior to the start of any excavation.
- G. Drill Set-Up: Design and construct the drill entrance and exit pits.
- H. Drilling Fluids: Mix the bentonite drilling fluid with potable water (of proper pH) to ensure no contamination is introduced into the soil during the drilling, reaming, or pipe installation process. Make any required additive adjustments.
- I. Drill Entrance and Exit Pits: Drill entrance and exit pits are required. Maintain at a minimum size to allow only the minimum amount of drilling fluid storage prior to transfer to mud recycling or processing system or removal from the Site. Do not allow drilling mud to flow freely on the Site or around the entrance or exit pits. Remove spilled mud and restore the ground to the original condition. Provide shore pits in compliance with OSHA Standards, 29 CFR 1926.652. Drilling near wetlands or watercourses requires secondary containment to prevent drilling fluids from entering the wetlands. Secure written approval of a secondary containment plan from the Architect and/or Construction Project Manager.
- J. Drill Entrance and Exit Angle: Ensure entrance and exit angles and elevation profile maintains adequate cover to reduce the risk of drilling fluid breakouts and ground exit occurs as specified herein. Ensure that entrance and exit angles generate pullback forces that do not exceed 12 percent strain on the high-density polyethylene pipe.
- K. Pilot Hole: The type and size of the pilot string cutting head and the diameter of the drill pipe are at the Contractor's discretion. Drill the pilot hole along the path shown on the plan and profile drawings. Pilot hole tolerances are as follows:
  - 1. Vertical Tolerance: Provide minimum cover below channel bottom as specified on the plans. The pilot hole may go deeper if necessary to prevent a breakout.
  - 2. Horizontal Tolerance: Plus or minus - 60 inches from the centerline of the product pipe.
  - 3. Curve Radius: No curve is acceptable with a radius of less than 1,000 feet.
  - 4. Entry Point Location: Make a pilot hole entry point within plus or minus - 60 inches of the location shown on the drawings or as directed by the Architect and/or Construction Project Manager in the field.
  - 5. Exit Point Location: Make the exit point location within plus/minus - 60 inches of the location shown on the drawings or as directed by the Architect and/or Construction Project Manager in the field.

6. Mandatory pipeline cover requirements are as shown on the drawings or as specified.

- L. Guidance System: Walkover guidance systems are not acceptable for this project; use a magnetic survey tool locator installed behind the pilot string cutting head and an electric grid (tru-tracker) system for this project. Ensure proper calibration of all equipment before commencing directional drilling operations.
- M. Reaming: Conduct reaming operations at the Contractor's discretion. Determine the type of back reamer to be utilized by the type of subsurface soil conditions that are encountered during the pilot hole drilling operation. The reamer type is at the Contractor's discretion.
- N. Pull Back: Fully assemble the entire pipeline to be installed via direction drill prior to commencement of pull back operations. Install a continuous length of tracer wire for the full length of each run of nonmetallic pipe in accordance with ANSI Z535.1. Attach a wire to the top of the pipe in such a manner that it will not be displaced during construction operations.

Support the pipeline during pullback operations in a manner to enable it to move freely and prevent damage. Install the pipeline in one continuous pull.

Minimize torsion stress by using a swivel to connect the pull section to the reaming assembly.

The maximum allowable tensile force imposed on the pull section is not to exceed 90 percent of the pipe manufacturer's safe pull (or tensile) strength. If the pull section is made up of multiple pipe sizes or materials, the lowest safe pull strength value governs and the maximum allowable tensile force is not to exceed 90 percent of this value.

Minimize external pressure during the installation of the pullback section in the reamed hole. Replace damaged pipe resulting from external pressure at no cost to the Owner. Buoyancy modification is at the discretion of the Contractor.

- O. Drilling Fluids Disposal: Collect drilling fluid returns in the entrance pit, exit pit, or spoils recovery pit. Immediately clean up any drilling fluid spills or overflows from these pits.

Dispose of fluids in a manner that is in compliance with all permits and applicable Federal, State, and local regulations. Disposal of the drilling fluids may occur on approved land owned by the Owner and it is subject to written approval from the Architect and/or Construction Project Manager. Spread the drilling slurry over the approved disposal area and plow into the soil.

- P. Conduct disposal in compliance with all relative environmental regulations, right-of-way and workspace agreements, and permit requirements.

- Q. Connection of Product Pipe to the Pipeline: After the product pipe has been successfully installed, allow the product pipe to recover for 24 hours prior to the connection of the pipeline. Ensure that a sufficient length of the product pipe has been pulled through the hole so that the pull-nose is not pulled back into borehole due to stretch recovery of the product pipe.

### 3.4 FIELD QUALITY CONTROL

#### A. Daily Work Log

Maintain a work log of construction events and operations including, but not limited to, the following for each day's work:

1. Hours worked.
2. Log of each drill rod added or withdrawn during drilling, reaming, and pull back.
3. Groundwater control operations.
4. Description of soil conditions encountered.
5. Tools and equipment in use, drilling fluid, fluid pumping rate, and drilling head location.
6. Any unusual conditions or events.
7. Reasons for operational shutdown in event work is halted.

#### B. Drill Logs

Maintain drilling logs that accurately provide drill bit location (both horizontally and vertically) at least every 5.1 cm 2 inches along the drill path. In addition, keep logs that record, as a minimum the following, every 15 minutes throughout each drill pass, back ream pass, or pipe installation pass:

1. Drilling Fluid Pressure.
2. Drilling Fluid Flow Rate.
3. Drill Thrust Pressure
4. Drill Pullback Pressure
5. Drill Head Torque

Make all instrumentation, readings, and logs available to the Architect and/or Construction Project Manager at all times during operation.

#### C. Field Tests

Perform field tests and provide labor, equipment, and incidentals required for testing. Submit test results, identifying any results that do not meet requirements, to the Architect and/or Construction Project Manager within four days of test completion. Provide corrective action and retest pipe not meeting requirements. Provide corrective action as recommended by the pipe manufacturer and subject to approval by the Architect and/or Construction Project Manager.

### 3.5 CLOSEOUT ACTIVITIES

Immediately upon completion of work, remove all rubbish and debris from the job site. Remove all construction equipment and implements of service, leaving the entire area involved in a neat condition acceptable to the Architect and/or Construction Project Manager.

Reinstall the wooden fence, jersey barrier, and any other items that were removed and store that relates to this part of the construction.

Patch bituminous concrete pavement and curbing, and restore striping.

Repair any gravel area if it was disturbed during the construction or from contraction equipment or activities.

Provide topsoil and seed the disturbed areas.

Remove all erosion and sedimentation devices when ground cover is established and dispose of the Site.

Immediately clean "blow holes" or "breakouts" of drilling fluid to the surface and return the surface area to its original condition. Dispose of all drilling fluids, soils, and separated materials in compliance with Federal, State, and local environmental regulations.

Provide a post-construction fusion report including the following data for each fusible connection:

1. Pipe Size and Thickness
2. Machine Size
3. Fusion Technician Identification
4. Job Identification
5. Fusion Joint Number
6. Fusion, Heating, and Drag Pressure Settings
7. Heat Plate Temperature
8. Time Stamp
9. Heating and Cool Down Time of Fusion
10. Ambient Temperature

### 3.6 AS-BUILT

- A. Final As-built of all constructed items for water main and sanitary sewer forcemain directional drilling location and elevations A-2 and T-2 accuracy prepared by a CT Licensed Land Surveyor in a paper, Mylar and AutoCAD format to be provided for the owner. Include in the record drawings a plan, profile, and all information recorded during the progress of the work. Clearly tie the record drawings to the project's survey control. Maintain, and submit upon completion, signed complete work logs of guided directional drill operations.

END OF SECTION 330523

## SECTION 331000 – EXTERIOR WATER UTILITIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Encroachment Permit is required from the CT DOT District 4 for work with the state ROW on Route #6. It is the Contractor's responsibility to obtain this permit and pay all applicable fees.
- A. The underground water distribution system begins at 5' beyond outside of buildings and to be completed and ready for operation, including water main and water and fire service all piping, structures, appurtenances, connections to new building's service lines, connections, required special fittings and restrains to the new pipes, installed by Directional Drilling, and existing water service lines, and all other incidentals.
- B. Water utility testing and disinfection.
- C. Coordination with the Connecticut Water Company and State Fire Marshal.
- D. Utility Company furnished products include water meters that will be furnished to the Site, ready for installation.
- E. The Contractor's responsibility includes furnishing, installing, monitoring, and maintaining Erosion and Sedimentation devices, as required by the Construction Documents. After the required work is completed and accepted, it is the Contractor's responsibility to remove the Erosion and Sedimentation devices and dispose of the Site.
- F. The Contractor's responsibility includes clearing and grubbing work areas, cutting and patching the bituminous pavement, disposing of the debris of the Site, restriping pavement, repairing gravel surfaces, protecting, dismantling, and reinstalling the wooden fence, Jersey barrier, and any other obstruction, and topsoiling and seeding disturbed lawn on the Black Rock State Park, the CT DEEP Maintenance garage property, 422 Watertown Road, and with CT DOT R.O.W, and Route 6. See the Project specifications, plans, and details for the restoration information.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Connecticut Water Company "Rules and Regulations of the Connecticut Water Company As Approved by DPUC on July 14, 2010".

- C. Connecticut Public Health Code Rules and Regulations.
- D. State of Connecticut Department of Transportation "The Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, as amended and merged with the July 2019 supplemental specifications.
- E. The Project is subject to General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities. Part of the General Permit, Stormwater Pollution Control Plan (SWPCP) is prepared and approved by CT DEEP for the Contractor to use.

### 1.3 RELATED SECTIONS

- A. Division 03, Concrete Specifications for the concrete.
- B. Section 220500 "Common Work Results for Plumbing" for General Plumbing, Protection of Materials and Equipment, and Quality Assurance
- C. Section 223000 "Plumbing Specialties" for Metering
- D. Division 26, Electrical.
- E. Section 312000 "Earthmoving".
- F. Section 312319 "Dewatering".
- G. Section 312333 "Trenching and Backfilling" for Excavation, Detectable Warning Tape, and Backfill.
- H. Section 312513 "Erosion Controls".
- I. Section 315000 "Excavation and Support and Protection" for Shoring, Sheet piling, and Bracing.
- J. Section 321216 "Asphalt Paving".
- K. Section 321313 "Concrete Paving".
- L. Section 321613 "Precast Concrete Curbing".
- M. Section 321723 "Pavement Markings".
- N. Section 329200 "Turf and Grasses".
- O. Section 331001 – CT Water Company Utilities Installation.

- P. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

#### 1.4 GENERAL REQUIREMENTS

- A. Install, monitor, and maintain all erosion and sedimentation devices prior to any site or work area disturbance. That includes but not limited: siltation fence, silt socks, construction entrances, haybales, and silt boom.
- B. Remove and safely store the wooden fence, jersey barrier, and any other obstruction.
- C. Cut bituminous concrete pavement and curbing, and dispose of the Site.
- D. Clear and grub work area and dispose of the debris of the Site.

#### 1.5 DEFINITIONS

- A. Water distribution system: Pipelines and appurtenances which are part of the distribution system outside the building for potable water and fire supply.
- B. Water service line: Pipeline from mainline to 5 feet outside of the building.

#### 1.6 ABBREVIATIONS

- A. DI: Ductile iron pipe.
- B. HDPE: High-density polyethylene.

#### 1.7 QUALITY ASSURANCE

- A. Comply with Section 331001 – CT Water Company Utilities Installation.
- B. Comply with the "Rules and Regulations of the Connecticut Water Company As Approved by DPUC on July 14, 2010".
- C. Comply with all rules and regulations of Federal, State, and Local Health Department, Department of Energy and Environmental Protection having jurisdiction over the design, construction, and operation of potable water systems.
- D. All material surfaces in contact with potable water shall comply with NSF 61.

- E. Perform testing in accordance with Hydrostatic Testing and Backflow Preventer Testing in Part 3 of this Section and . Section 331001 – CT Water Company Utilities Installation.
- F. Perform flushing and disinfection in accordance with Flushing and Disinfecting in Part 3 of this Section and Section 331001 – CT Water Company Utilities Installation.
- G. Piping materials shall bear a label, stamp, or other markings of a specified testing agency.
- H. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for the intended use.
- I. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.
- J. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.
- K. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.
- L. NSF Compliance: Comply with NSF 14 for plastic potable-water-service piping.
- M. Comply with NSF 61 for materials for water-service piping and specialties for domestic water
- N. Inform the Connecticut Water Company and State Fire Marshal prior to backfill in order that they may make an inspection and test to assure that the service pipe and installation complies with the Connecticut Water Company and the State Fire Marshal requirements. Testing is to include pressurizing the service pipe and a visual inspection of all joints for leakage. After inspection and approval of the trench, the depth of the invert of the service may not be reduced to less than five feet, nor may any connection be made to the service pipe between the street shutoff and the meter. If the Contractor does not schedule the inspection prior to backfill, the Connecticut water Company and the State Fire Marshal may require that the pipe be re-excavated, at the Contractor's expense, to allow them Company to perform the necessary inspection. No service pipe shall be turned on without prior approval by the Connecticut Water Company.
- O. Products Criteria:
  - 1. Multiple Units: When two or more units of the same type or class of materials or equipment are required, these units shall be a product of one manufacturer.
  - 2. Nameplate: Nameplate bearing the manufacturer's name or identifiable trademark securely affixed in a conspicuous place on equipment or name or trademark cast integrally with equipment, stamped, or otherwise permanently marked on each item of equipment.



- P. Regulatory Requirements:
  - 1. Install potable water line to meet minimum State-mandated separation distance from sewer lines. Water service may not be laid in the same trench with other underground utility facilities. Separation distances of at least ten feet (measured horizontally) shall be maintained between any existing or proposed sanitary sewer piping, sewer manholes, septic tanks or any portion of a subsurface sewage disposal system.

## 1.8 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Detail precast concrete vaults, manholes, risers, frame and cover, and vault assemblies and indicate dimensions, method of field assembly, and components.
- C. Pipes, fittings, joints, restraints, valves, concrete, and indicate dimensions, method of field assembly, and components.
- D. Wiring Diagrams: Power, signal, and control wiring for alarms, if required.
- E. Coordination Drawings: For piping and specialties, including relation to other services in the same area, drawn to scale. Show piping and specialty sizes and valves, meter and specialty locations, and elevations.
- F. Shop drawings and calculations all specials fittings, joint restraint systems, adapters, and couplings that require connect DI pipe to HDPE.
- G. Field quality-control test reports.
- H. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Preparation for Transport: Prepare valves, including fire hydrants, according to the following:
  - 1. Ensure that valves are dry and internally protected against rust and corrosion.
  - 2. Protect valves against damage to threaded ends and flange faces.
  - 3. Set valves in the best position for handling. Set valves closed to prevent rattling.
- B. During Storage: Use precautions for valves, including fire hydrants, according to the following:
  - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.

2. Protect from the weather. Store indoors and maintain temperature higher than ambient dew-point temperature. Support off the ground or pavement in watertight enclosures when outdoor storage is necessary.
- C. Handling: Use a sling to handle valves and fire hydrants if size requires handling by crane or lift. Rig valves to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.
- D. Deliver piping with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe-end damage and to prevent entrance of dirt, debris, and moisture.
- E. Protect stored piping from moisture and dirt. Elevate the above grade. Do not exceed the structural capacity of the floor when storing inside.
- F. Protect flanges, fittings, and specialties from moisture and dirt.
- G. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

#### 1.10 PROJECT CONDITIONS

- A. Interruption of Existing Water-Distribution and Fire distribution Services: Do not interrupt service to facilities occupied by the Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
- B. Notify Construction Manager, Property Owner, Architect, CT. Water Company, and State Fire Marshalls no fewer than two days in advance of the proposed interruption of the service.
- C. Do not proceed with interruption of water-distribution and fire –distribution-service without Construction Manager and Architect's written permission.

#### 1.11 COORDINATION

- A. Coordinate the connection to the water main with the Connecticut Water Company.
- B. Coordinate all work within the State Right of Way with Connecticut Department of Transportation District 4. Maintenance and protection of traffic within the State Right of Way shall be provided by the Contractor as required by CTDOT.
- C. Encroachment Permit is required from the CT DOT District 4 for work with the state ROW on Route #6. It is the Contractor's responsibility to obtain this permit and pay all applicable fees.

## PART 2 - MATERIALS AND PRODUCTS

### 2.1 WATER PIPING

#### A. Copper Tube and Fittings

1. Service pipes 1-inch through 2-inches in diameter must be of Copper Tube, Type K, soft temper with no soldered joints underground.
  - a. Must conform to the latest revision standard specification for seamless copper water tube, ASTM B 88.
2. Fittings for underground copper service pipe should be flared or Iron Pipe Size (I.P.S.) thread connections only, and conform to the latest revision of AWWA Standard C800.
3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint end. Furnish Class 300 flanges if required to match piping.
4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

#### B. Ductile Iron Pipe and Fittings

1. Refer to Section 331001, Water Main Materials.
2. Service pipes 4-inches in diameter or larger should be of ductile iron cement lined minimum Class 52 or a class with a wall thickness suitable for pressures and loads encountered. The ductile iron pipe should conform to the latest revision of AWWA Standard C151. The ductile iron pipe should be furnished with a double cement-mortar lining. The lining should conform to the latest revision of AWWA Standard C104.
3. Fittings for service pipes 4 inches and larger should be restrained mechanical joint or push-on joint only. Flanged fittings should not be used underground. All fittings should be made of double cement mortar lined ductile iron and should conform to the latest revision of AWWA Standard C110.

### 2.2 WATER VALVES

#### A. Curb Stop Valve

1. Refer to Section 331001, Water Main Materials.

#### B. Service Valves

1. Refer to Section 331001, Water Main Materials.

#### C. Curb boxes

1. Refer to Section 331001, Water Main Materials.
2. Plastic curb boxes and curb box covers are prohibited.

#### D. Post Indicator Valve, if applicable.

1. Description: Galvanized cast-iron body, bolted cover with air-bleed device for access to internal parts, and flanged ends. Include one-piece bronze disc with bronze bushings, pivot, and replaceable seat. Include threaded bypass taps in inlet and outlet for bypass meter connection. Set the valve to allow minimal water flow through bypass meter when major water flow is required.
  - a. Standards: UL 312 and FMG approved.
  - b. Pressure Rating: 175 psig.
  - c. Water Meter: AWWA C700, disc type, at least one-fourth size of the detector check valve. Include meter, bypass piping, gate valves, check valve, and connections to the detector check valve.

### 2.3 CONCRETE VAULTS (METER PIT)

- A. Precast, reinforced-concrete vault designed for HS-20 load designation according to ASTM C 857 and made according to ASTM C 858.
  1. Ladder: ASTM A 36/A 36M, steel or polyethylene-encased steel steps.
  2. Manhole: ASTM A 48/A 48M Class No. 35A minimum tensile strength, gray-iron traffic frame and cover.
    - a. Dimension: 24-inch minimum diameter, unless otherwise indicated.
  3. Drain: ASME A112.6.3, cast-iron floor drain with the outlet of the size indicated. Include body anchor flange, light-duty cast-iron grate, bottom outlet, and integral or field-installed bronze ball or clapper-type backwater valve.

### 2.4 WATER METERS

Water meters will be furnished by the Connecticut Water Company and paid for by the Contractor.

### 2.5 HYDRANTS

1. Refer to Section 331001, Water Main Materials.

### 2.6 WARNING TAPE

- A. Warning tape will be metalized plastic, blue in color, a minimum of 3-inches in width and have the words "CAUTION - WATER LINE BURIED BELOW" imprinted on it in black letters.
- B. Trace wire will be made of Copper 12 gauge.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Refer to Division 31, Section 312333 "Trenching and Backfilling" and Section 331001 "CT Water Company Utilities Installation" for excavating, trenching, and backfilling.

#### 3.2 PIPING, VALVES, AND JOINT INSTALLATION

- A. Refer to Section 331001, Water Main Materials.
- B. Except where water pipes are not intended for use during freezing weather and are actually drained during such periods, all water pipes shall be laid a minimum of 4 or 5 feet (as indicated on the drawings) below the finished grade in order to prevent freezing. If at any time the grade is changed so that any part of the water pipe is covered by less than 4 or 5 feet (as indicated on the drawings), the Owner will be responsible for draining the pipe before freezing weather occurs. Where the water pipe is not laid to depth, a separate drain valve with curb box must be provided adjacent to the curb valve.
- C. It is the Contractor's expense and responsibility to ensure that water and fire service pipes installed maintaining a vertical separation distance of 18 inches from pipe crown to pipe bottom with sanitary sewer and storm pipes, while maintaining 4 or 5 feet (as indicated on the drawings) cover over the pressurized water and fire service pipes.
- D. Water and fire service pipes are to be inspected by the Connecticut Water Company and State Fire Marshal to assure that the installation conforms to these Specifications and water company's requirements. The Contractor shall schedule the inspection prior to backfilling the connection excavation. Backfill material should be compacted around and one foot over the pipe. When excavation is in rock, there should be no projecting rock within 6 inches of the outside of the pipe side, top and bottom. The bottom 6 inches of the trench should be refilled with sand and properly compacted before the pipe is laid. All excavated rock should be disposed of and the trench refilled with sand, gravel or other suitable material.
- E. The Contractor shall be responsible for ensuring the stability and safety of the trench and adjacent structures by using such trench support and bracing as deemed necessary by applicable OSHA standards.
- F. Since the Contractor must maintain all excavations in proper condition for carrying on the work, the Contractor shall do all bailing, draining or pumping which may be necessary to keep the trenches or other excavations free of water, and will not, under any conditions, allow groundwater to enter the pipes.
- G. The Contractor must notify "CALL BEFORE YOU DIG" (1-800-922-4455 or "811") prior to the start of any excavation.

- H. Clearances, should not be less than 18 inches where water and fire service pipes cross other underground utilities.
- I. No water pipe should cross any portion of a subsurface sewage disposal system or be installed less than 10 feet away from any portion of a subsurface sewage disposal system.
- J. Water pipes shall not be in the same trench with other underground facilities, except as approved and in accordance with the requirements of the Connecticut Public Health Code.
- K. In accordance with current state laws, rules and regulations, blue warning tape is required on all water service installations. Warning tape will be installed no less than 12 inches and no more than 18 inches above each water or fire service pipe.
- L. For water pipe 2 inches and smaller, all fittings from the corporation stop in the water main up to and including the service valve on the upstream side of the meter should be flared or Iron Pipe Size (I.P.S.) thread connections only.
- M. In all cases, soldered connections will not be allowed anywhere along the water line from the corporation stop at the water main up to the point where the water enters the place of use and within the meter setting.
- N. In no case will connections be allowed on the service pipe upstream of a water meter.
- O. Check valves, pressure reducing valves, backflow prevention devices, booster pumps, and other such equipment must be located downstream of the meter.
- P. Transition couplings and special fittings with pressure ratings at least equal to piping pressure rating may be used, unless otherwise indicated.
- Q. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.
- R. Provide special fitting and required restrains for the connection from Directional Drilling 8-inch. HDPE DIPS SDR 7 to 8" DI pipe at the proposed water main on the Black Rock State Park property in the Town of Watertown.
- S. Provide special fitting and required restrains for the connection from Directional Drilling 8-inch. HDPE DIPS SDR 7 to 8" DI pipe to the proposed meter vault on the CT DEEP Garage property in the Town of Thomaston
- T. Mechanical joint anchor fittings shall be used to transition from HDPE to DI or PVC. The fitting shall be stronger than the pipe in that when it is subjected to tensile stress, the pipe will pull apart before the fitting will pull out and the pipe blow before the fitting will rupture under pressure.
- U. The mechanical joint Adapter shall have a pre-installed stainless-steel stiffener, in accordance with Plastic Pipe Institute (PPI) recommendations, to neutralize point-loading, ACQ, creep and

loss of gasket seal due to diameter contraction. The stiffener shall be engineered sufficiently thick to avoid radial buckling due to gasket pressure.

- V. The Mechanical Joint Adapter requires longer bolts and shall be sold with the modified longer bolt kit to avoid construction delays or improper installation with too shorth bolts.
- W. All pressurized fittings shall be rated according to the manufacturer's written specifications, and clearly labeled on the fitting as such.

### 3.3 CONCRETE VAULT INSTALLATION

- A. Install precast concrete vaults, according to ASTM C 891.

### 3.4 FIRE HYDRANT INSTALLATION

- A. Comply with the Section 331001 "CT Water Company Utilities Installation" and the State Fire Marshall's Office requirements.
- B. General: Install each fire hydrant with a separate gate valve in a supply pipe, anchor with restrained joints or thrust blocks, and support in an upright position.
- C. AWWA Fire Hydrants: Comply with AWWA M17.
- D. UL/FMG Fire Hydrants: Comply with NFPA 24.
- E. Install post-type flushing hydrants with a valve below the frost line and provide for drainage. Support in an upright position. Include a separate gate valve or curb valve and restrained joints in the supply piping.

### 3.5 FIRE DEPARTMENT CONNECTION INSTALLATION

- A. Fire department connection installation shall comply with specifications and details the Connecticut Water Company, State Fire Marshal, Town of Thomaston Fire Marshall, Town of Watertown Fire Marshall, and Connecticut Public Health requirements.
- B. Install ball drip valves at each check valve for fire department connection to mains.

### 3.6 FIRE CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.
- B. See Division 22 for piping connections to valves and equipment.

- C. Connect water-distribution piping to utility water main. Use the Connecticut Water Company, State Fire Marshal, Town of Thomaston Fire Marshall, Town of Watertown Fire Marshall, and Connecticut Public Health Code, approved connection method.
- D. Connect water-distribution piping to interior domestic water and fire-suppression piping.
- E. Ground equipment according to Division 26 for Electrical Systems.
- F. Connect wiring according to Division 26.

### 3.7 FIELD QUALITY CONTROL

- A. Refer to the Section 331001 “CT Water Company Utilities Installation”.
- B. Notify the Connecticut Water Company and State Fire Marshall's Office Piping Tests:
- C. Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize the system. Use only potable water.
- D. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours or as required by Water Division.
  - 1. Increase pressure in 50-psig increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig. Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints. Remake leaking joints with new materials and repeat the test until leakage is within allowed limits.
- E. Prepare reports of testing activities.

### 3.8 IDENTIFICATION

- A. Install continuous underground detectable warning tape during the backfilling of the trench for underground water-distribution piping. Locate below-finished grade, directly over piping.

### 3.9 CLEANING

- A. Refer to the Section 331001 “CT Water Company Utilities Installation”.
- B. Clean and disinfect water-distribution piping as required by the Connecticut Water Company and Connecticut Public Health Code.
- C. Clean and disinfect water-distribution piping as follows:



1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
  2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if the method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of the outlet.
  3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if the method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
    - a. Fill system or part of the system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.
    - b. Drain system or part of the system of the previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
    - c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from the system.
    - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if the biological examination shows evidence of contamination.
- D. Prepare reports of purging and disinfecting activities.

### 3.10 CLOSEOUT ACTIVITIES

- A. Refer to the Section 331001 “CT Water Company Utilities Installation”.
- B. Immediately upon completion of work, remove all rubbish and debris from the job site. Remove all construction equipment and implements of service, leaving the entire area involved in a neat condition acceptable to the Architect and/or Construction Project Manager.
- C. Reinstall the wooden fence, jersey barrier, and any other items that were removed and store that relates to this part of the construction.
- D. Patch bituminous concrete pavement and curbing, and restore striping.
- E. Repair any gravel area if it was disturbed during the construction or from contraction equipment or activities.
- F. Provide topsoil and seed the disturbed areas.
- G. Remove all erosion and sedimentation devices when ground cover is established and dispose of the Site.

3.11 AS-BUILT

- A. Final As-built of all constructed items for water main, domestic and fire water services location and elevations A-2 and T-2 accuracy prepared by a CT Licensed Land Surveyor in a paper, Mylar and AutoCad format to be provided for the Owner and CT Water Comapny.

END OF SECTION 331000

SECTION 331001 – CT WATER COMPANY UTILITIES INSTALLATION



**THE CONNECTICUT WATER COMPANY  
SPECIFICATIONS**

**TRENCHING, BACKFILLING AND INSTALLING  
DUCTILE IRON WATER MAINS AND APPURTENANCES**

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**SECTION I.**  
**GENERAL CONDITIONS**

**DEFINITION OF TERMS**

The word "CWS" or "COMPANY" is used to designate Connecticut Water Services, whose principal place of business is at Clinton, Connecticut, or its duly authorized representatives for whom the work is to be performed. The word "Contractor" is used to designate the party or parties contracting or agreeing to perform the work or his or their heirs, executors, administrators, successors or assigns.

The word "Inspector" or "Engineer" refers to the person appointed by CWS to inspect the work and shall extend to and include any assistant whom he may designate.

The word "Work" is used to designate the work, materials and things required to be done, furnished or performed by the Contractor under the specifications.

Wherever the words "directed", "required", "performed", or words of like import are used, it shall be understood that the direction, requirement or permission of CWS is intended, and similarly the words "approved", "acceptable", "satisfactory" or words of like import shall mean approved by or acceptable or satisfactory to CWS.

**WORK TO BE DONE**

The work to be done includes (except as here-in-after otherwise specified) furnishing all materials, labor, tools, plant and equipment required for receiving, inspecting, hauling, distributing, installing, testing and disinfecting the ductile iron water pipes and appurtenances including valves, fittings, hydrants, excavation and backfill; removing and replacing pavements, proper retirement/abandonment-in-place of existing mains, all as shown on the drawings, mentioned in the specifications or ordered by CWS, complete in every detail, ready for operation.

**MATERIALS MANAGEMENT**

The Contractor will order, schedule delivery, receive, unload and store all ductile iron water pipe, fittings, valves, valve boxes, tapping sleeves, joint restraints, fire hydrants, chlorine tablets, polyethylene wrap, service line copper and brass, curb boxes, marking tape, etc., and all other materials required for completion of the project. The Contractor shall procure all materials necessary for completion of the project (in accordance with CWS Purchasing Standards), schedule delivery, unload and store the materials until needed for the project. Certain items may be procured directly by CWS from designated suppliers with the contractor handling those items as indicated above. Upon delivery to the project or storage site the Contractor is responsible for the safe keeping of all delivered materials.



### **LOCATION OF THE WORK**

The work is located in public streets, easements, right of way, or authorized property as approved by CWS.

### **PERMITS AND BONDS**

The Contractor will be responsible for obtaining and paying for all the necessary Highway and local permits, unless otherwise obtained by CWS.

The Contractor shall obtain the necessary State of Connecticut D.O.T. Permit Bond when working within the State Highway Right-of-Way.

### **SUPERVISION OF WORK**

The Contractor shall be solely responsible for supervision of the Work, shall give the Work the constant attention necessary to ensure the expeditious and orderly progress thereof, and shall cooperate with the Engineer in every possible way.

At all times, the Contractor shall have as his representative on the site a superintendent reasonably acceptable to the Engineer and adequately licensed for the installation of water main, capable of reading and thoroughly understanding the Drawings, Specifications and other Project Documents, with full authority to execute the directions of the Engineer without delay and to implement all safety rules, precautions and programs required and to supply promptly such labor, services, materials, equipment, plant, apparatus, appliances, tools, supplies and other items as may be required. Such superintendent shall not be removed from the site without the prior written consent of the Engineer. If, in the opinion of the Engineer, the superintendent or any successor proves unacceptable, CWS shall give written notice and the Contractor shall replace the superintendent reasonably acceptable with another person approved by the Engineer; such approval, however, shall in no way relieve or diminish the Contractor's responsibility for supervision of the work or for implementation of all safety rules, precautions and programs required. Such superintendent or other representative shall also be responsible for insuring that each of Contractor's agents, servants, employees and subcontractors observes and complies with all safety rules, precautions and programs required under the "Health, Safety and Protection" and "Safety Compliance" Sections of the General Conditions.

In the event the Contractor does not meet the requirements of the Engineer, the Engineer reserves the right to stop work for reasons set forth above. The Contractor shall be responsible for any additional costs or delays resulting from such a stoppage of work.

### **COMPLIANCE WITH LAWS**

The Contractor shall keep himself fully informed of all federal, state, and local laws, ordinances, rules, and regulations affecting those engaged or employed on the Work, the materials and equipment used in the Work and the conduct of the Work, and of all orders, decrees and other requirements of bodies or tribunals having any jurisdiction or authority over the same, as well as

any amendments, revisions or changes thereto. If any discrepancy or inconsistency is discovered in the Drawings, Specifications or other Project Documents or in the Work in relation to any such law, ordinance, rule, regulation, order, decree or other requirement, the Contractor shall forthwith report the same to the Engineer in writing. The Contractor shall at all times observe and comply with, and cause all his agents, servants, employees and subcontractors to observe and comply with all such existing and future laws, ordinances, rules, regulations, orders, decrees and other requirements, and he shall protect, indemnify and save harmless to the fullest extent of the law CWS, its officers, agents, servants and employees from and against any and all claims, demands, suits, proceedings, liabilities, judgments, penalties, losses, damages, regulatory fines, costs and expenses, including attorneys' fees, arising from or based upon any violation or claimed violation of any such law, ordinance, rule, regulation, order, decree or other requirement, whether committed by the Contractor or any of his agents, servants, employees or subcontractors; provided, however, that the foregoing indemnity shall not extend to a case involving liability for damage arising out of bodily injury to persons or damage to property caused by or resulting from the sole negligence of any such indemnities.

### **ANTI-HARASSMENT**

The CWS is committed to maintaining a work environment free of discrimination. Contractor understands that in the course of providing services , it shall comply with all federal, state and local laws relating to equal opportunity and non-discrimination in employment, including without limitation Conn. Gen. Stat. 46a-54(15)(B) (related to training supervisors in the prevention of sexual harassment); 46a-60 (prohibiting discrimination on the basis of race, color, religious creed, age, sex, gender identity or expression, marital status, national origin, ancestry, present or past history of mental disability, intellectual disability, learning disability or physical disability and genetic information), and Conn. Gen. Stat. 46a-81(c) (prohibiting discrimination on the basis of sexual orientation).

### **HEALTH, SAFETY AND PROTECTION**

The Contractor shall take all necessary and appropriate precautions for the safety of, and shall provide necessary and appropriate protection to prevent damage, injury or loss to:

1. All agents, servants, employees or subcontractors of the Contractor involved in the Work and other persons who may be affected thereby, including without limitation the agents, servants, employees and subcontractors of CWS, the Engineer, CWS's other contractors and adjoining property owners and other persons on or nearby the Site:
2. All Work and materials and equipment incorporated or to be incorporated therein, whether in storage on or off the Site, under the care, custody or control of the Contractor or any of his agents, servants, employees or subcontractors; and
3. Other property at the Site or adjacent thereto, including without limitation trees, shrubs, lawns, walks, pavements, roadways, structures and utilities.

The Contractor shall be solely responsible for initiating, implementing, maintaining, supervising, enforcing and assuring compliance with safety rules, precautions and programs which satisfy and comply with all federal, state and local laws, rules, regulations, orders, codes and standards applicable to the performance of the Work, including but not limited to all occupational safety and health standards and requirements adopted or recognized under the Occupational Safety and Health Act of 1970, 29 C.F.R. Part 1926; 29 C.F.R. Part 1910; Conn. Gen. Stat. §31-367 to 31-385 (1987); Conn. Agencies Regs. §31-372-107-1926 (1987), and any amendments or changes to any thereof.

The Contractor shall also cause all of his agents, servants, employees and subcontractors to observe and comply at all times with all such safety rules, precautions and programs.

The Contractor shall observe and comply with all federal, state and local environmental and health laws, rules, regulations, orders, codes and standards applicable to the handling, disposal, storage, generation or management of any "hazardous substance" as defined in 42 U.S.C. §9601, or any "hazardous waste" as defined in Conn. Gen. Stat. §22a-115.

The Contractor shall be responsible for establishing hazard communication programs to transmit information on the hazards of chemicals and other substances being used, and all related matters of safety, to all of his agents, servants, employees and subcontractors by means of labels on containers, material safety data sheets, training programs and any other reasonable safeguards and procedures for safety and protection, in accordance with 29 C.F.R. Part 1926.20 and Conn. Gen. Stat. §§31-370; 31-40c-f, 40g, 40j-1 (1987).

The Contractor is responsible for complying with all MSDS requirements. It is the Contractor's responsibility to make his personnel aware of the hazards associated with the materials furnished by The Connecticut Water Company and the safety precautions suggested for handling and use.

If the Company or its Inspector or Engineer observes any conditions which do not comply with the requirements of this Project, CWS may instruct the Contractor's superintendent or other representative to promptly correct such noncomplying conditions.

The Contractor shall provide sufficient, proper and safe facilities at all times for the inspection or observation of the Work and Site by CWS and its authorized representatives, including without limitation such facilities as are necessary to permit CWS and such representatives to observe compliance with all safety rules, precautions and programs required under this Project

While CWS may provide the Contractor with assistance in monitoring safety rules, precautions and programs, and CWS may correct noncomplying conditions which the Contractor has failed to correct promptly, such action shall in no way obligate CWS to conduct safety inspections or identify or correct noncomplying conditions, nor will it relieve the Contractor from any obligations prescribed above, all of which shall remain the sole responsibility of the Contractor.

In the event the Contractor does not meet any requirement described above, the Engineer reserves the right to stop work until such time that the Contractor corrects the noncomplying

condition. The Contractor shall be responsible for additional costs or delays resulting in the work stoppage.

The Contractor shall protect, indemnify and save harmless The Connecticut Water Services, the Engineer and their respective officers, agents, servants and employees from and against any and all claims, demands, suits, proceedings, liabilities, judgments, penalties, losses, damages, costs and expenses, including attorneys' fees, arising from or based upon any violation or claimed violation of any of the provisions of the Supervision of Work, Compliance with Laws, and the Health, Safety and Protection, and Safety Compliance Sections of these general conditions; provided, however, Contractor shall not be liable under this section to the extent that any such liabilities, losses, fines, penalties, damages, costs, actions, expenses, claims, demands, liens, encumbrances, judgments, administrative proceedings, or suits arise out of or result from the negligence or willful misconduct or breach by the Indemnified Parties.

### **SAFETY COMPLIANCE**

The Contractor shall take all necessary precautions and provide all necessary safeguards to prevent personal injury and property damage. The Contractor shall provide protection for all persons including but not limited to his employees and employees of other contractors or subcontractors; members of the public; and employees, agents, and representatives of the Owner, the Engineer, and regulatory agencies that may be on or about the Work. The Contractor shall provide protection for all public and private property including but not limited to structure, pipes, and utilities, above and below ground.

The Contractor shall provide and maintain all necessary safety equipment such as fences, barriers, signs, lights, walkways, guards and fire prevention and firefighting equipment and shall take such other action as is required to fulfill his obligations under this subsection.

The Contractor shall also familiarize himself with The Connecticut Water Company's Safety Manual and comply with all applicable sections.

### **JOB SITE EVALUATION**

CWS will provide the Contractor with scorecard reviews. The frequency of review will be job specific with the intent to provide open honest communication to the Contractor in reference to their performance. Job site decorum shall be at the highest level. Actions such as, but not limited to, foul language and fighting that could negatively impact CWS's brand or image will not be tolerated. The Company reserves the right to stop work until any issues have been resolved to the Company's satisfaction. Evaluation forms will be used to determine the Contractor's suitability for future work.

### **WATER**

Upon notification by the Contractor to the Company water required for reasonable use in the construction and testing of the work may be secured by the Contractor, at a cost from an ap-

proved water main location, as available. The Contractor shall lay all connecting lines of such size as are necessary for his operations.

### **COMMENCEMENT OF WORK**

The Contractor shall commence work on the site within a reasonable timeframe after notice from CWS to do so. He shall commence work at such points as CWS shall direct and shall thereafter continue at such points and in such order of precedence as CWS may from time to time direct. He shall notify CWS whenever his construction crew is at the job site.

### **TIME OF COMPLETION**

The Contractor shall complete the entire project, ready for operation, not later than the date as required by the project. Work shall be consistent, without unnecessary break or delays, to completion.

### **EMPLOYMENT OF SUFFICIENT LABOR AND EQUIPMENT**

If in the sole judgment of the Inspector the Contractor is not employing sufficient labor, plant, equipment or other means to complete the Work, the Inspector may, after giving written notice, require the Contractor to employ such additional labor, plant, equipment and other means and as the Inspector deems necessary to enable the Work to progress properly.

### **PROJECT DRAWINGS**

Project drawings (when available) and these specifications are complementary. What is called for by one shall be considered called for by both. Any construction deviation from the project drawings must be approved by CWC.

### **MATERIALS AND WORKMANSHIP**

All materials and workmanship shall be the best of their several kinds and subject to the approval of the Inspector or other designated Company official except where otherwise specifically mentioned.

### **LINES, GRADES AND MEASUREMENTS**

For work requiring lines, grades and measurements, the Contractor shall employ a competent engineer to establish all lines, elevations, reference marks, batter boards, etc., needed by the Contractor during the progress of the Work, and from time to time to verify such marks by instrument or other appropriate means.

The Engineer shall be permitted at all times to check the lines, elevations, reference marks, batter boards, etc., set by the Contractor, who shall correct any errors in lines, elevations, reference marks, batter boards, etc., disclosed by such check. Such a check shall not be construed to be an approval of the Contractor's work and shall not relieve or diminish in any way the responsibility

of the Contractor for the accurate and satisfactory construction and completion of the entire work.

For his work, the Contractor shall make, check, and be responsible for all measurements and dimensions necessary for the proper construction of and the prevention of misfitting of work.

### **INSPECTION DURING CONSTRUCTION**

CWS will appoint an Inspector to: inspect all materials and workmanship; document project safety compliance; and see that the work conforms to the specifications and drawings.

The failure of the Inspector to reject or condemn improper materials and workmanship shall not prevent CWS from rejecting materials and workmanship found defective at any time prior to the final acceptance of the completed work, nor shall it be considered as a waiver of any defects which may be discovered later, or as preventing CWS at any time subsequently from recovering damages for work actually defective.

The Contractor shall provide sufficient, safe and proper facilities at all times for inspection.

The Inspector shall be furnished by the Contractor with every reasonable facility for examining and inspecting the work and for ascertaining that the Work is being performed in accordance with the requirements and intent of the Contract, even to the extent of requiring the uncovering of portions of finished work by the Contractor.

Should the work thus uncovered prove satisfactory, the cost of uncovering and the replacement thereof shall be considered as extra work unless the original work was done in violation of the Contract or in the absence of the Inspector and without his written authorization, in which case said cost shall be borne by the Contractor. Should the work uncovered prove unsatisfactory, said cost shall be borne by the Contractor.

### **INSURANCE COVERAGE**

The Contractor shall obtain the required insurance as indicated on attached Insurance Certificate and shall submit duplicate copies of the executed forms upon execution of this Proposal and Contract. The Contractor shall also provide said copies upon Certificate renewal as appropriate throughout the term of the agreement.

In addition to the submission of the aforementioned Certificate, CWS requires a blanket Additional Insured Endorsement. This insurance shall apply as Primary and non-contributing insurance before any other insurance or self-insurance, including any deductible, maintained by, or provided to, the additional insured. Further, CWS requires ISO Additional Insured Endorsements CG 2010 and CG 2037, or equivalent. In the event insurance is cancelled, CWS requires a minimum of 30 days-notice of policy cancellation.



Contractor shall maintain CGL coverage for itself and all additional insureds for the duration of this agreement and maintain Completed Operations coverage for itself and each additional insured for at least 1 year after the completion of each project.

### **WAIVER OF SUBROGATION**

Contractor waives all rights against CWS and their agents, officers, directors and employees for recovery of damages to the extent these damages are covered by commercial general liability, commercial umbrella liability, business auto liability or workers compensation and employers liability insurance maintained by the requirements stated or referred to in the insurance section above.

### **TAXES**

Contractors are directed to the provision of the Connecticut Sales and/or Use Tax Law and particularly to Regulation No. 90 of the Connecticut State Tax Dept. - Sales and Use Tax Division, as amended, entitled "Contractors and Subcontractors". It will be noted that, in accordance with the provisions of the aforesaid Regulation No. 90, Contractors in any contract resulting from this inquiry will be considered responsible for remitting to the State of Connecticut all Sales and/or Use Taxes which may be applicable under said contract. Therefore, quotations submitted in connection with this inquiry shall be prepared in accordance with the provisions of the aforesaid tax law. CWS will provide the required tax exemption certificate for purchase of all materials required for the completion of the project as indicated.

The Connecticut Water Company reserves the right, if necessary, to require additional breakdowns and supplemental information, such as copies of backup records, for any statement to The Connecticut Water Company from each Contractor or supplier, e.g., cost of materials, services, transportation, delivery and installation costs.

All other taxes of any nature imposed with respect to such equipment, the manufacture, sales or use thereof or the materials incorporated therein or with respect to Contractor's or supplier's performance of the contract or its receipts, income or profits thereunder, shall be the sole responsibility of the Contractor.

**Nonresident contractors will be required to show proof of compliance with bonding requirements contained in the State of Connecticut Department of Revenue Services Special Notice 2005 (12). As outlined in DRS SN 2005 (12), any nonresident contractor will be required to furnish a cash or guarantee bond for 5% of the total contract price.**

### **GENERAL GUARANTEE**

The Contractor agrees to guarantee his work for a period of one (1) year from and after the date upon which the Company has accepted the installation. He shall during this period repair promptly at his own cost and expense all breaks, failures, defects or site restoration issues which develop in his work as a result of faulty material or workmanship furnished by him.

If they cannot perform such work promptly, they are liable to pay the reasonable cost for such repairs as performed by CWS or its agents.

### **JOB MEETINGS**

The Contractor will be required to meet prior to commencement the project and periodically thereafter with Company representatives to discuss scheduling, sequence of operations, and coordination of the work.

### **CARE AND RESTORATION OF PROPERTY**

The Contractor shall enclose the trunks of trees adjacent to his work that are not to be cut, with substantial wooden boxes of such height as may be necessary to protect them from injury from piled material, from equipment, from his operations, or otherwise due to his work. Excavating machinery and cranes shall be of suitable type and be operated with care to prevent injury to trees not to be cut and particularly to overhanging branches and limbs.

Branches, limbs, and roots shall not be cut except by permission of the Engineer. All cutting shall be smoothly and neatly done without splitting or crushing. In case of cutting or unavoidable injury to branches, limbs, and trunks of trees, the cut or injured portions shall be neatly trimmed and covered with an application of grafting wax or tree healing paint as directed.

If cultivated hedges, shrubs, and plants are injured to such a degree as to affect their growth or diminish their beauty or usefulness, they shall be replaced by items of kind and quality at least equal to the kind and quality existing at the start of the work at no additional cost to CWS. Any damage to pipes, drainage structures or other utilities, whether active or abandoned, shall be repaired by the Contractor at no additional cost to CWS.

All surfaces (including paved roadways, parking areas, driveways and sidewalks) which have been injured by the Contractor's operations shall be restored to a condition at least equal to that in which they were found immediately before work was begun. Suitable materials and methods shall be used for such restoration.

The restoration of existing property or structures shall be done as promptly as practicable and shall not be left until the end of the construction period.

### **CALL BEFORE YOU DIG**

**The Contractor shall, at least seven full working days prior to the start of work, notify Call Before You Dig (CBYD) (1-800-922-4455 or 811) for the location and marking of all underground utilities in the work area, and shall provide CWS with the "CBYD Ticket No." of said mark out request.**

**CBYD excavation notices expire at the end of 30 calendar days from the date notice is given to the clearing house. If construction is not completed or is expected to last beyond 30 calendar days, a renewal notice must be provided to CBYD before the expiration.**



**The Contractor is to comply with all current Call Before You Dig Regulations.**

**CONTRACTOR'S RESPONSIBILITY FOR MATERIALS FOR AND EQUIPMENT**

The Contractor shall assume full responsibility for all supplies, materials and equipment required by him for the work he contracts to do, whether furnished by him or by CWS until the same shall have been installed and finally tested and accepted.

**CLEANING UP**

During its progress, the work and the adjacent areas affected thereby shall be kept cleaned up and all rubbish, surplus materials, and unneeded construction equipment shall be removed and all damage repaired so that the public and property owners will be inconvenienced as little as possible.

Where material or debris has washed or flowed into or been placed in existing watercourses, ditches, gutters, drains, pipes or structures, in connection with work done under this contract, or elsewhere during the course of the Contractor's operation, such material or debris shall be entirely removed and satisfactorily disposed of during the progress of the work, and the ditches, channels, drains, pipe structures, and work, etc., shall upon completion of the work be left in a clean and neat condition.

On or before the completion of the work, the Contractor shall, unless otherwise specifically directed or permitted in writing, tear down and remove all temporary buildings and structures built by him, shall remove all temporary works, tools, and machinery or other construction equipment furnished by him, shall remove all rubbish from any grounds which he has occupied, and shall leave the roads and all parts of the premises and adjacent property affected by his operations in a neat and satisfactory condition.

The Contractor shall not dispose of any excess excavated materials on the adjacent properties, unless written approval has been secured from the property owner. The Contractor shall furnish to CWS a copy of the property owner's approval prior to the disposal of any materials.

The Contractor shall restore or replace, when and as directed, any public or private property damaged by his work, equipment or employees to a condition at least equal to that existing immediately prior to the beginning of operations. To this end the Contractor shall do as required all necessary highway or driveway, walk and landscaping work. Suitable materials, equipment and methods shall be used for such restoration.

## SECTION II

### TRENCHING, BACKFILLING AND INSTALLING DUCTILE IRON WATER MAINS AND APPURTENANCES

#### WORK TO BE DONE

The work to be done includes furnishing all materials, labor, tools, plant and equipment required for receiving, inspecting, hauling and distributing materials, removing pavement; excavation and backfill; and installing, disinfecting and testing the ductile iron water piping and appurtenances including valves and fittings; proper retirement/abandonment-in-place of existing mains; providing As Built installation sketches; all as shown on the drawings, (when available) specified herein or ordered by CWS; complete in every detail, ready for operation.

#### REMOVING PAVEMENTS

Where existing streets, road or highways are paved within the limits of the trench, such pavement or surfacing shall be removed to the extent necessary for the work.

Prior to pavement removal, the pavement shall be cut by jackhammer, wheel, trench milling or saw cut. Saw cutting of pavement where required prior to permanent pavement placement.

#### DIMENSIONS

The width of trenches shall be sufficient to permit proper alignment of the pipes and thorough tamping of the backfill around and under the pipes in their final location. There shall be at least twelve (12) inches clear opening at all points between the outside of the pipe and the sides of the trench. Where trenches are sheeted, the specified clear opening shall be provided between the inside face of the sheeting and the outside of the pipe.

All water mains shall be installed as shown on the plans and to the line and grades as shown on the profiles, if provided. The minimum depth of cover shall be 4 feet. For the crossing of sewers, storm drainage or other utilities the water main shall be laid to the elevations as shown on the plans, or as directed by the Inspector but in no case shall the separation between the two be less than 18" vertical unless specifically approved by the Inspector.

Where necessary to avoid existing structures, to secure suitable foundations or to conform to future grading of streets or side-walks, a greater or lesser depth may be authorized by CWS. If the trench is excavated to a depth greater than specified or authorized, the Contractor shall refill the trench to the required depth with suitable material thoroughly tamped.

## **TRENCHING**

In excavating trenches, the Contractor may use such methods as CWS will approve. Where the use of trenching machines is permitted, he shall before starting work, obtain all available information as to the location of existing underground structures, and shall plainly mark their location in advance of the excavation. The length of trench excavated ahead of the pipe laying, and the length of trench which may remain open at one time shall at all times be subject to the approval of CWS. It shall at no time be greater than can properly be protected from caving.

## **TUNNELING**

Excavation shall be made in open cut. No tunneling will be permitted unless under written authorization of CWS.

## **EXCAVATION AND BACKFILLING**

The Contractor shall perform all necessary excavation and backfilling called for in these specifications or as required by CWS, including the necessary sheeting, shoring, pumping, bailing, supporting and protecting existing structures and repairing them when damaged, and removing or altering existing underground obstructions which are owned by private parties.

## **ROCK EXCAVATION**

Rock excavation and replacement backfill shall include the cost of excavating, hauling and disposing of material classified as rock, the dressing of surface to receive structures, refilling trenches under pipelines, the exclusion and removal of water from the site of the work, and the furnishing of all materials and labor, tools, plant and equipment necessary to the performance of the work herein specified, permits for rock excavation will be pass through costs with no markup.

If material suitable for backfilling is not available in sufficient quantity from other excavations, the Contractor shall, at his own expense, furnish suitable material from outside sources.

Rock excavation shall include solid rock in place, detached rocks, sound masonry and concrete, measuring more than one (1.0) cubic yard, but shall not include pavements or sidewalks.

The Contractor shall obtain all permits and observe all rules and regulations of authorities having jurisdiction relative to the handling, storing and use of explosives, and shall exercise every care in blasting operation to protect life and property.

No charge shall be used which is larger than necessary to split the rock.

When, in the opinion of CWS, it is desirable to do so, CWS may prohibit blasting and order rock to be removed by mechanical means. Mechanical means shall be classified as rock removed by jackhammer or hoe ram. Rock removed by pounding or scraping with an excavator bucket and rock teeth shall not be classified as removal by mechanical means.

Excavation in rock trench for pipelines shall provide at least twelve (12) inches clearance below the outside bottom of the pipe and around the pipe with the space refilled with acceptable well-compacted sand.

### **ADDITIONAL EXCAVATION**

If, in the opinion of the Engineer, the material below normal grade of the excavation is unsuitable for foundation, it shall be removed and disposed of to such limits as the Engineer may direct.

### **BACKFILL**

Backfilling material for at least one (1) foot above the top of the pipe shall consist of selected fine material containing no stones larger than one-half inch in size. Backfill of the fine selected material shall be carefully and thoroughly tamped with approved tools in such a manner as to prevent settlement. Special care shall be taken to place the best sandy or gravelly material under the pipe on the quarters and to bring it up solidly so as to furnish a hard bed for the whole of the lower part of the pipe.

**The required backfill above the one-foot layer of fine selected material may be placed in one layer provided it is compacted by means of a hoe-pack to achieve a 95% modified proctor density. If a hoe-pack is not used, the backfill shall be spread in layers not exceeding twelve (12) inches in depth prior to compaction. Each layer shall be carefully and thoroughly tamped with approved tools in such a manner as to prevent settlement after the backfill has been completed and to achieve a 95% modified proctor density. If in the opinion of the "Engineer or Inspector" the compaction of the backfilled trench is not suitable, compaction tests will be required to verify that proper compaction was achieved. All costs for compaction tests will be borne by the Contractor.**

Blue marking tape reading "Caution - Water Line Below" shall be placed a minimum of 24" above the top of the water main.

The use of frozen material will not be permitted. The excavated paving, either bituminous or other, shall not be placed in the trench as backfill.

All settlement in backfill shall be repaired by the Contractor at his expense.

Prior to placement of permanent pavement all trenches shall have sufficient compaction to achieve a 95% modified proctor density.

### **BANK RUN GRAVEL**

All excavation shall be classed as earth excavation or rock excavation.

Earth excavation shall include sand, gravel, ashes, loam, clay, swamp muck, soft or disintegrated rock or hardpan which can be removed with a pick, or a combination of such materials, and

boulders measuring less than one (1.0) cubic yard whether the boulders are blasted or removed intact.

At the option of the inspector, replacement gravel shall be either bank run gravel or select gravel which meet the following gradations.

A. Bank Run Gravel

Bank run gravel shall have a gradation within the limits given below. It shall be obtained from approved natural deposits and unprocessed except for the removal of unacceptable material and stones larger than the maximum size permitted. It shall not contain vegetation, masses of roots, or individual roots more than 18 inches long or more than 1/2 inch in diameter. It shall be substantially free from loam and other organic matter, clay, and other fine or harmful substances.

<u>Sieve Size</u>	<u>Percentage by Weight Passing</u>
6 in.	100
3-1/2 in.	90-100
1-1/2 in.	55-95
1/4 in.	25-60
No. 10	15-45
No. 40	5-25
No. 100	0-10
No. 200	0-5

B. Select Gravel

Select gravel shall have a gradation within the limits given below. It shall be obtained from approved natural deposits and unprocessed except for the removal of unacceptable material and stones larger than the maximum size permitted. It shall not contain vegetation. It shall be free from loam and other organic matter, clay, and other fine or harmful substances.

<u>Sieve Size</u>	<u>Percentage by Weight Passing</u>
3 in.	100
1/2 in.	80-100
No. 4	60-80
No. 40	10-30
No. 200	0-10

**CUTTING PIPE**

Pipe shall be cut by means of a pipe saw or other approved method in accordance with the manufacturer's operating instructions for the equipment to produce a clean true cut, free from

irregularities and leave a smooth end at right angles to the axis of the pipe. All bevels shall be made with appropriate grinding equipment

### **INSTALLING DUCTILE IRON PIPE**

All pipes shall be carefully examined for defects and no piece shall be installed which is known to be defective. If any defective piece is discovered after having been installed, it shall be removed and replaced with a sound one at the expense of the Contractor. All pipes and fittings shall be thoroughly cleaned before they are installed and shall be kept clean until they have been accepted in the completed work.

Where directed by CWS, each piece of pipe and each fitting shall be installed upon blocking set at no less than two (2) different points along its length. The blocking shall be sound timber two (2) inches thick, twelve (12) inches wide and of a length equal to the diameter of the pipe. Wedges twelve (12) inches long, of four (4) inch by four (4) inch sound timber, shall be placed on the blocking to hold the pipes and special castings in position.

Blocks shall be firmly bedded on the trench bottom slightly below the grade of the finished pipe before the pipes are placed. After the pipes have been lowered into the trench, the wedges shall be placed and adjusted so as to bring the pipe to proper alignment and grade.

### **OBSTRUCTIONS**

The Contractor shall lay the pipes or pipe lines through or around all permanent obstructions which may be encountered on or below the surface, and make all necessary removals or alterations of existing underground structures which are owned by private parties.

The attention of the Contractor is directed to the fact that there may be existing sanitary sewers and laterals, gas and water mains with services in all streets along with telephone, electric, cable TV or other underground utilities. CWS will furnish assistance to the Contractor in establishing the location of these systems on the site. If the Contractor should damage or break any of the above items, he shall repair the damaged service at his own cost.

### **JOINTS**

All pipe joints will be push-on type rubber gasketed unless otherwise specified. All fittings and valves will be of the mechanical joint type with Mega Lug retainers unless otherwise specified. Locking gaskets shall be placed a minimum 3 full pipe lengths from the end of all dead end lines and blow offs. At all change of direction, locking gaskets shall be installed a minimum of 2 full pipe lengths from the fitting.

### **RUBBER GASKET JOINT**

Rubber gasket joints will be of the compressed rubber ring gasket type. The joints shall be thoroughly cleaned, prepared and installed in strict accordance with the requirements, instructions and recommendations of the joint manufacturer and of CWS.

Only rubber gaskets furnished by the manufacturer of the pipe shall be used. Gaskets which have become damaged or which are defective in any way shall not be used in the work. Gaskets shall be stored in a cool, dark and dry place and shall be kept warm prior to their use in cold weather. Jointing materials in addition to the gaskets, if required by the type of joint furnished, shall fully comply with and be installed in accordance with the requirements of the manufacturer of the joint.

### **POLYETHYLENE ENCASEMENT**

Polyethylene encasement shall be installed around water main ductile iron pipe and appurtenance installations including hydrant laterals and barrel to ground level and all associated service lines, three (3) feet from the main connection, and also shall be installed as directed by CWS Project Personnel and as directed by the Inspector.

Polyethylene encasement shall be installed in accordance with AWWA standard C105-99 method "A", or latest revision thereof, at locations as directed. The polyethylene tube shall be cut to a length approximately 2 feet longer than that of the pipe section. Slip the tube around the pipe, providing a 1-foot overlap at each end. Lower the pipe into the trench and make up the pipe joint, overlapping the wrap at the joint. Take up the slack width to make a snug, but not tight, fit along the barrel of the pipe. Repair any rips, punctures, or other damage with adhesive tape or with a short length of polyethylene tube cut open then wrapped around the pipe and secured in place.

### **TESTS AFTER INSTALLATION**

After the pipe has been installed and backfilled, all newly installed pipe shall be subjected to a pressure and leakage test conducted in accordance with AWWA Standard C600-99, Section 5 and as follows.

#### **A) Pressure Test:**

All newly installed pipe shall be subjected to a hydrostatic pressure of 1.5 times the working (system) pressure at the point of testing, but in no case less than 1.25 times the working pressure at the highest point along the test section. The test pressure shall not exceed pipe or thrust restraint design limits, twice the rated pressure of closed valves or hydrants located within the test area, or the rated pressure of closed resilient-seated gate or butterfly valves. The test shall be maintained for a minimum of two hours with no more than a 5 psi variation during the test period.

#### **B) Leakage Test:**

The leakage test will be conducted at the same time as the pressure test. Leakage is the quantity of water required to maintain the pressure within 5 psi of the specified test pressure, it is not the measured drop in pressure. Leakage shall not exceed the number of



gallons per hour as determined by the inspector, and is indicated in Table 6 of the above specified AWWA Section.

### C) General.

Before applying the specified test pressure, all air shall be expelled from the pipe. If hydrants or blow offs are not available at high places, the Company shall make the necessary taps at points of highest elevation before the test is made and insert the plugs, if desired, after the test has been completed. The section to be tested shall be closed by valves, temporary flanges, plugs or bulkheads as required.

Each valved section of pipe shall be slowly filled with water and the specified test pressure shall be applied by means of a pump connected to the pipe in a manner satisfactory to the inspector. The pipe connection and all necessary apparatus including pump shall be furnished by the Contractor. The Contractor shall furnish all necessary labor and materials for conducting the tests.

If leakage is either visible or indicated by the above test procedure, the Contractor shall do whatever is necessary to locate and repair said leak at his own expense. Upon completion of the repair the pipeline shall be retested.

## **DISINFECTION**

Before any section of pipeline is put into service, it shall be thoroughly disinfected in accordance with AWWA Standard C651-99, Section 4.4.2.

Chlorine tablets (5 G calcium hypochlorite) shall be supplied and placed by the Contractor on the inside top of each length of main as it is laid using Dow Corning 732 adhesive or an approved NSF-61 equal. The number of tablets used per length of pipe shall be as is indicated in Table 2 of the above specified AWWA Section (one for 6", two for 8", four for 12", etc.).

The completed line shall be slowly filled with water and allowed to stand under pressure for at least 24 hours before being thoroughly flushed. A sample of water from the section shall be collected for analysis in a sterilized bottle by CWS.

No section of main shall be put into service without the approval of CWS, and should the analysis be unsatisfactory, the section shall again be disinfected and retested until an analysis satisfactory to CWS is obtained. All costs for a second disinfection and retesting shall be borne by the Contractor.

## **APPURTENANCES**

The Contractor shall exercise care in planning the work to arrange for the proper setting of all fittings, valves and other appurtenances required in the completed pipe lines. Fittings shall be properly supported with additional blocking if required to maintain the pipe lines in alignment. All bends and tees shall be securely anchored by poured concrete blocking or dry wedged



blocking. As needed, all friction clamps, thrust rods and miscellaneous exposed metal threads are to be coated with asphaltum.

Special attention shall be given to the accurate placing of valves so that they will not be subject to undue strains, and where required by CWS, they shall be supported on sound timber blocking. Valves shall be set with their stems truly vertical. Valve boxes shall be carefully placed to insure the free and proper operation of the valves.

### **PROTECTION OF THE PUBLIC**

Improved streets, roads, driveways and sidewalks shall be kept open over all trenches and excavations and the use thereof rendered safe by the construction of substantial timber bridges with proper handrails where required.

### **MATERIAL HANDLING**

The Contractor will order, schedule delivery, receive, unload, and store until required for installation all materials necessary to complete the project complete and ready for use in accordance with the project plans

### **TRAFFIC CONTROL**

Traffic control will be the responsibility of the Contractor. Traffic control is to be provided to the satisfaction of CWS and the governing authority.

### **BARRICADES, FLASHERS AND SIGNING**

Any construction equipment plant, materials or obstruction placed on streets, roads or walks, and all open excavations shall be carefully marked and protected by barricades with flashers and construction safety fence.

The Contractor shall supply, place, and maintain traffic signs and cones to the extent necessary to provide the signing pattern(s) required by the state, local, or governing agency or as requested by the Company.

### **ROADWAYS TO BE KEPT CLEAR**

The Contractor shall dispose of his plant, construction and excavated materials so as not to obstruct streets, roads, highways or private rights of way. He shall not obstruct the gutter of any street, road or highway, but shall take such measures as will insure the free passage of surface and storm waters along the gutters. All excavated materials shall be placed in a neat manner on one side of the trenches and shall be kept trimmed up so as to inconvenience the traveling public and adjacent property owners as little as possible. The utmost care shall be used to avoid interference with the ordinary use of the existing streets, roads or highways.

No portion of any street shall be closed to traffic unless written permission of the proper Civil Authorities has first been obtained.

### **DUST CONTROL**

The Contractor shall keep on the job sufficient supplies of calcium chloride to be applied at locations and at such times and in amounts as directed for the purpose of allaying dust conditions. Roadway sweeping shall be performed at the end of each workday to remove all debris from the roadway surface. The cost of such work shall be included in prices submitted for excavation, backfilling and laying of ductile iron water main.

### **SHEETING, BRACING AND COFFERDAMS**

To prevent injury to the work or delay in construction, all excavations shall be maintained in good order and all necessary precautions taken to prevent movement of the sides.

### **HANDLING OF WATER**

The Contractor shall at all times take such precautions as are necessary to keep the work free from ground or surface water. He shall provide pumps of adequate capacity to remove from the excavations the water which may enter and in such a manner that it will not interfere with the progress of the work or the proper placing of the pipe.

### **HANDLING MATERIALS**

Proper and suitable tools for safe and convenient handling and installation of pipes, fittings and valves shall be used. Great care shall be taken to prevent damage to the protective coating. Minor damage to exterior coating may be patched with asphaltum. Excessively damaged material shall be removed.

### **LOAMING AND SEEDING**

Shall include all labor, material, including top soil, and equipment required to loam and seed areas as directed. A limit of ten (10) feet wide shall be utilized unless otherwise indicated or field conditions require additional loaming and seeding.

Areas to be seeded shall be carefully graded, raked, fertilized and seeded with first quality grass seed, applied in accordance with the directions of the supplier. The Contractor shall place approved loam or topsoil on those surfaces and at the locations directed by CWS. All topsoil shall be screened containing stones no larger than ½ in diameter. It shall be placed accurately to a thickness of not less than two (2) inches and to the lines and grades directed by CWS. It shall be rolled with a light roller. After placing loam or topsoil, the surface shall be fertilized and seeded with suitable materials as approved by CWS. Seeding shall be done immediately after preparation of the top surface for which it is ordered. Seeded areas are to be covered with shredded straw. Hydro seeding of topsoil is the approved alternative to traditional seeding with straw cover.

If there is delay for which the Contractor is responsible and weeds grow on such surfaces, they shall be removed by the Contractor and the area resurfaced. After reseeding, the surfaces shall be hand raked and rolled with a light roller.

Care shall be taken to have the surfaces conform to the proper lines and grades and any sliding or settlement which may occur shall be repaired by the Contractor at his own expense. All seeded or re-sodded areas shall be thoroughly watered when required by CWS. They shall be maintained by the Contractor until permanently established and shall be subject to the one (1) year guarantee of his work.

**Section VIII**  
**Standard Details, SD-1 thru SD-25**

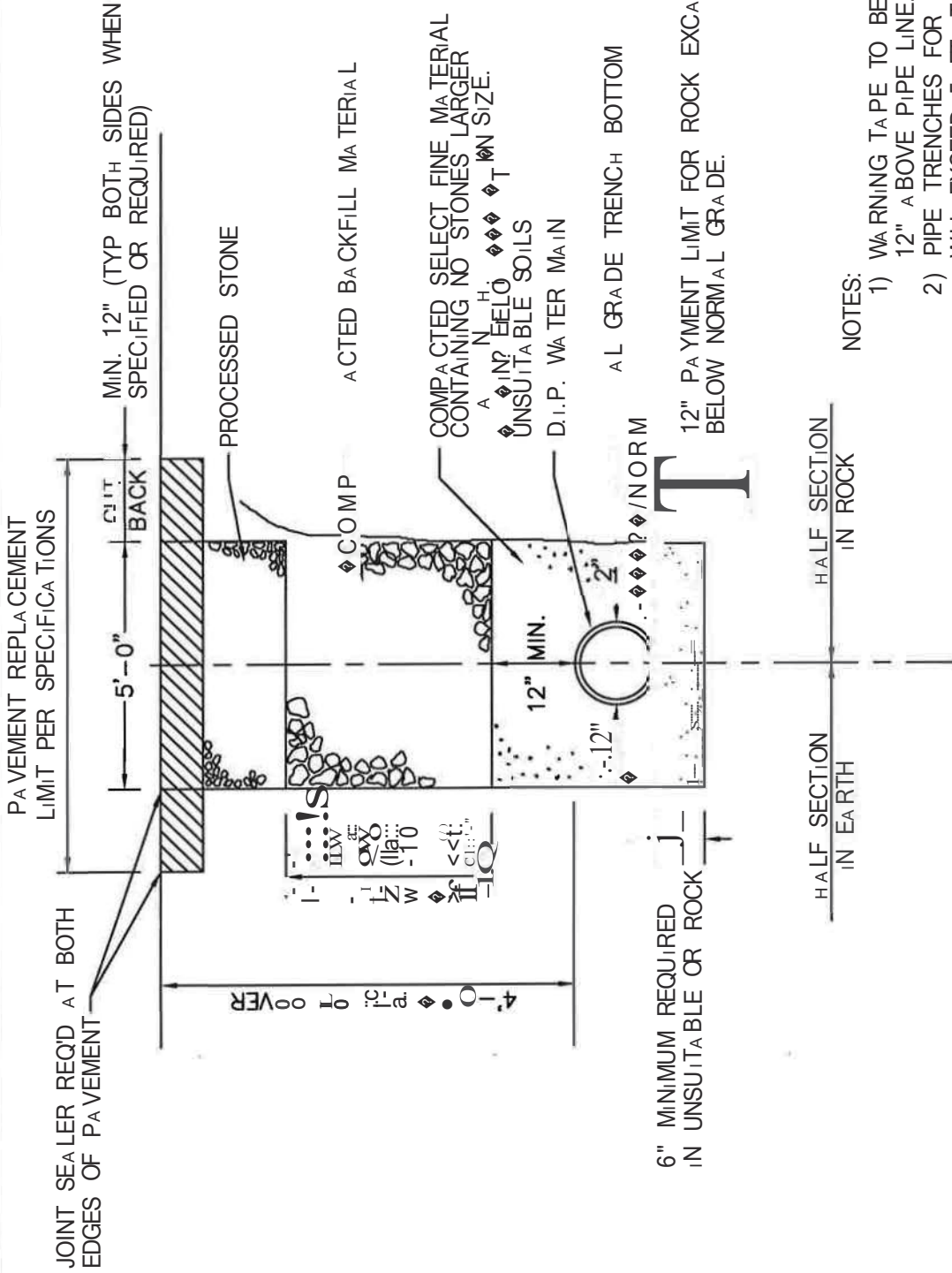


# WATER MAIN INSTALLATION STANDARD DETAILS

## INDEX

- SD-1 WATER MAIN INSTALLATION DETAIL - TYPICAL TRENCH & PAYMENT LIMITS
- SD-1A WATER MAIN INSTALLATION DETAIL (MULTIPLE MAINS) - TYP. TRENCH & PAY LIMITS
- SD-2 THRUST BLOCK DETAILS
- SD-3 STOP COLLAR DETAIL
- SD-4 HYDRANT INSTALLATION DETAIL
- SD-5 4" -12" WATER MAIN DEAD END BLOW-OFF DETAIL
- SD-6 AIR RELEASE DETAILS
- SD-9 PAVEMENT DETAILS-STATE AND TOWN ROADS
- SD-9A PAVEMENT DETAILS - STATE AND TOWN ROADS
- SD-10 CATCH BASIN SILT BARRIER DETAIL
- SD-11 EROSION & SEDIMENT CONTROL DETAILS
- SD-22 SEPARATION FROM STORM AND SEWER LINES DETAIL
- SD-23 WATER SERVICE ELECTRICAL BONDING PROCEDURE

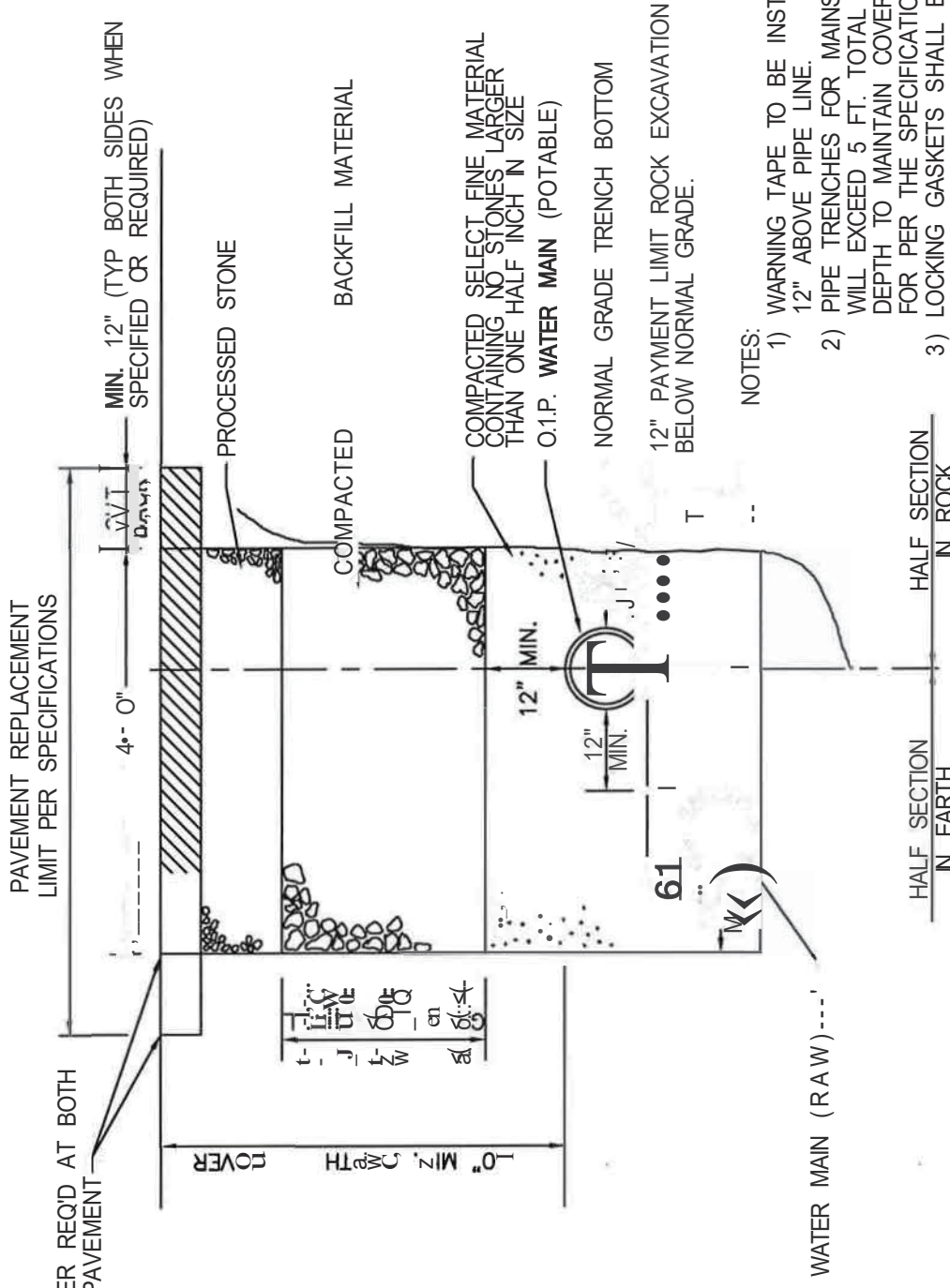
Rev. 3/3/17



NOTES:

- 1) WARNING TAPE TO BE INSTALLED A MIN. OF 12" ABOVE PIPE LINE.
- 2) PIPE TRENCHES FOR MAINS ABOVE 12" DIA. WILL EXCEED 5 FT. TOTAL DEPTH.
- 3) ALL DUCTILE IRON WATER MAIN AND FITTINGS ARE TO BE POLYWRAPPED.

Down By: LRS/LMM	Scale: NTS
Date: 3/6/17	Drawing Number <b>SD-1</b>
Approved by: <i>[Signature]</i> PROJECT ENGINEER	BU Number - Sheet 1 of 1
<b>Conn11cicutwa11r</b> 93 WEST MAIN STREET CLINTON, CT 06413-1600 www.ctwater.com	
<b>WATERMAIN INSTALLATION DETAIL TYPICAL TRENCH &amp; PAYMENT LIMITS</b>	



PAVEMENT REPLACEMENT LIMIT PER SPECIFICATIONS

MIN. 12" (TYP BOTH SIDES WHEN SPECIFIED OR REQUIRED)

PROCESSED STONE

BACKFILL MATERIAL

COMPACTED SELECT FINE MATERIAL CONTAINING NO STONES LARGER THAN ONE HALF INCH IN SIZE

O.I.P. WATER MAIN (POTABLE)

NORMAL GRADE TRENCH BOTTOM

12" PAYMENT LIMIT ROCK EXCAVATION BELOW NORMAL GRADE.

- NOTES:
- 1) WARNING TAPE TO BE INSTALLED A MIN. OF 12" ABOVE PIPE LINE.
  - 2) PIPE TRENCHES FOR MAINS ABOVE 12" DIA. WILL EXCEED 5 FT. TOTAL DEPTH. ADDITIONAL DEPTH TO MAINTAIN COVER WILL BE PAID FOR PER THE SPECIFICATIONS.
  - 3) LOCKING GASKETS SHALL BE INSTALLED A MIN. OF 2 FULL PIPE LENGTHS ON EITHER SIDE OF A BEND AND 3 FULL LENGTHS BEFORE END OF MAIN.
  - 4) ALL DUCTILE IRON WATER MAIN AND FITTINGS ARE TO BE POLYWRAPPED.

Scale: NTS

Drawing Number

SD-1A

BU Number - of 1

Sheet 1 of 1

**WATERMAIN INSTALLATION  
DETAIL (MULTIPLE MAINS)  
TYPICAL TRENCH &  
PAYMENT LIMITS**

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Drawn By: LRS/LMM

Date: 3/6/17

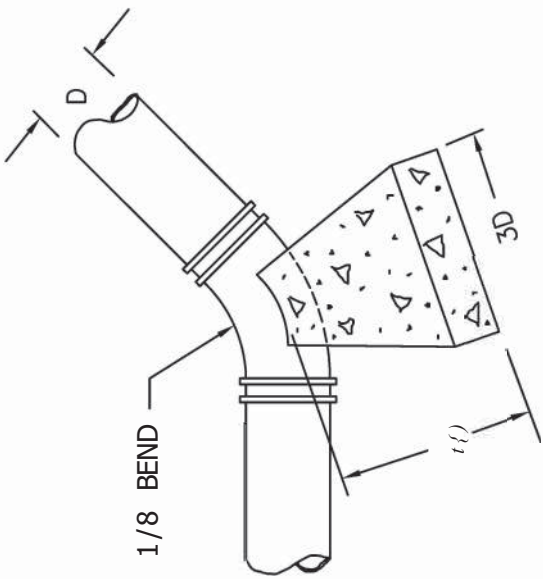
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*[Signature]*

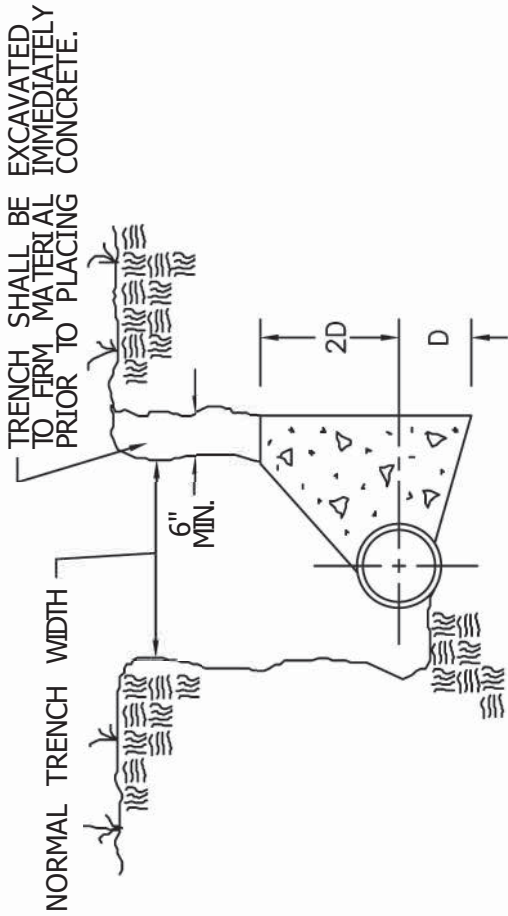
THE DEVELOPER SERVICES BOARD

THE MGR. PROJECT ENGINEERING

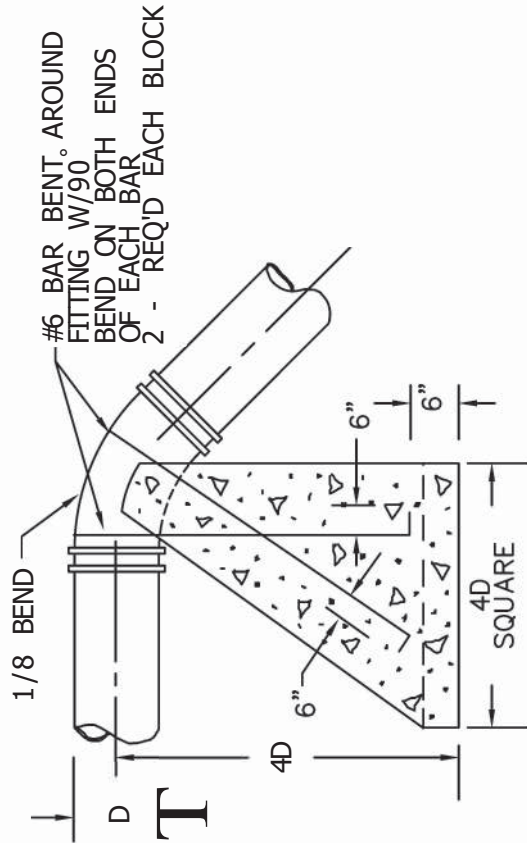




HORIZONTAL THRUST BLOCK DETAIL (PLAN VIEW)



HORIZONTAL THRUST BLOCK DETAIL



VERTICAL THRUST BLOCK DETAIL

NOTES:

- 1) 3000 PSI CONCRETE TO BE USED FOR THRUST BLOCKS.
- 2) D-DIAMETER OF WATER MAIN.
- 3) MEGA-LUG RESTRAINING GLANDS SHALL BE USED ON ALL MJ FITTINGS.
- 4) SOLID CONCRETE BLOCKS WITH WEDGES WILL BE PERMITTED ON MAINS UP TO 10' ALL 12" OR LARGER SHALL BE POURED THRUST BLOCKS.
- 5) LOCKING GASKETS SHALL BE INSTALLED A MIN. 2 FULL PIPE LENGTHS ON EITHER SIDE OF A BEND.

Down By: LRS
Date: 1/30/12
Approved by: _____
Title: _____
Title: G

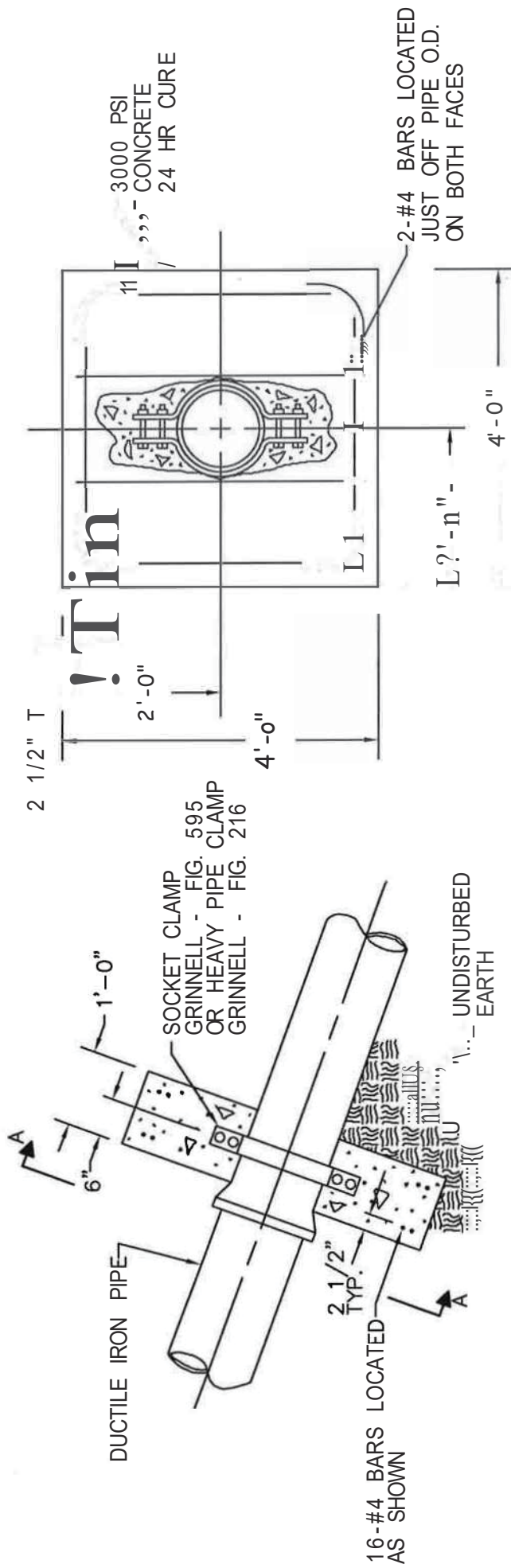
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**THRUST BLOCK  
DETAILS**

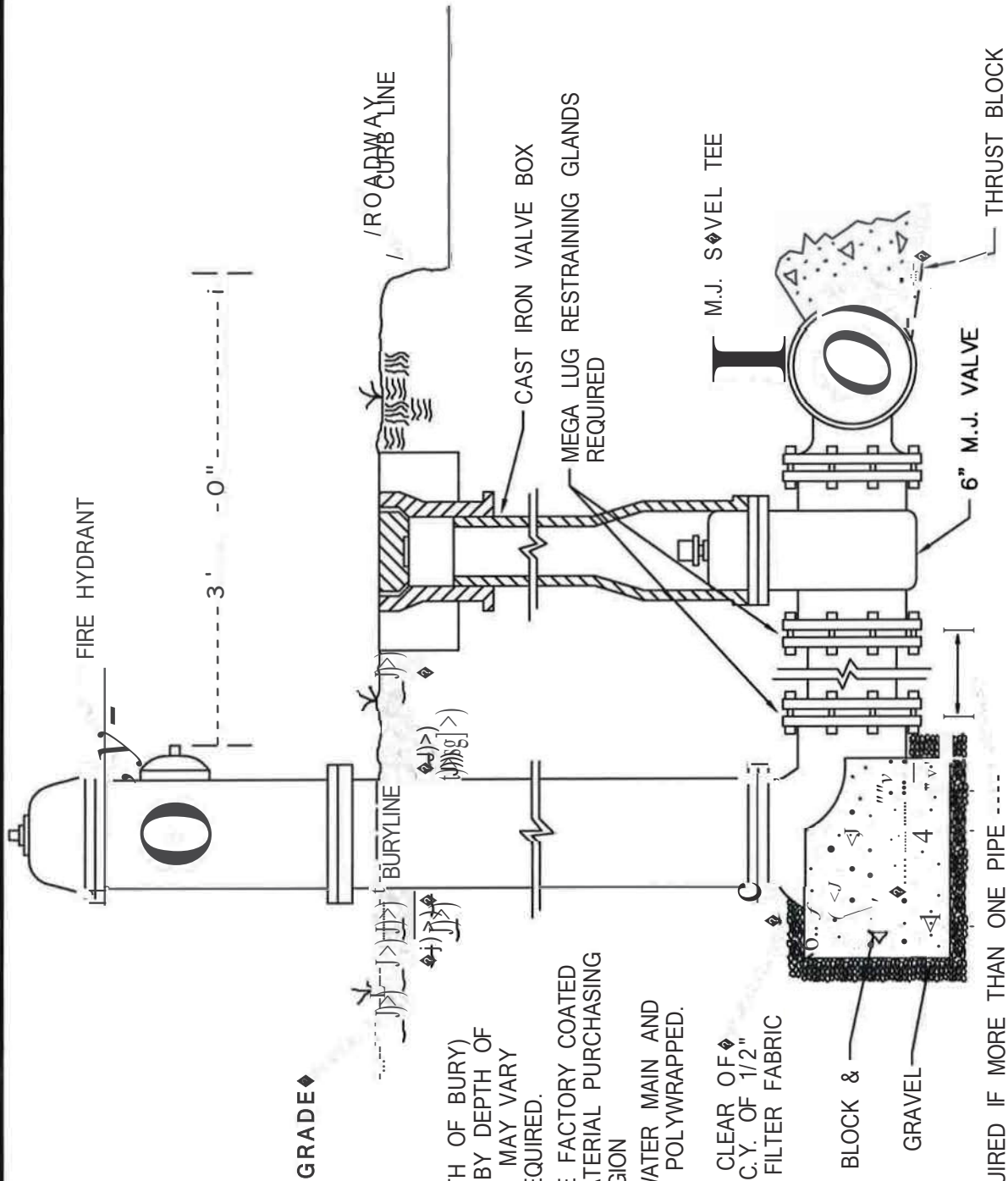
Scale: NTS
Drawing Number <b>SD-2</b>
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NOTE: ALL DIMENSIONS ARE MINIMUM, AND WILL BE DETERMINED BY EWC CONSIDERING PIPE SIZE, OPERATING PRESSURE AND SOIL CONDITIONS.

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Date: 1/10/17		Drawing Number <b>SD-3</b>
Approved by:  <small>THE DEVELOPED SERVICES COORD.</small> <small>TRC MGR. PROJECT ENGINEERING</small>	BU Number - X Sheet 1 of 1	
<h2>STOP COLLAR DETAIL</h2>		
Construction Documents 5/13/2020		



NOTES:

- 1) HYDRANT SIZE (DEPTH OF BURY) TO BE DETERMINED BY DEPTH OF WATERMAIN. DEPTHS MAY VARY 4 1/2' TO 6' AS REQUIRED.
- 2) HYDRANTS SHALL BE FACTORY COATED WITH COLOR PER MATERIAL PURCHASING STANDARDS FOR REGION
- 3) ALL DUCTILE IRON WATER MAIN AND FITTINGS ARE TO BE POLYWRAPPED.

BE SURE DRAIN IS CLEAR OF CONCRETE WITH 1 C.Y. OF 1/2" BROKEN STONE IN FILTER FABRIC AROUND DRAINS

CONCRETE THRUST BLOCK & HYDRANT BASE

FIELD LOK REQUIRED IF MORE THAN ONE PIPE

Drawn By: LRS/LMM

Date: 3/6/17

Approved by:

*Bruce M. Lemay*  
 THE DEVELOPER SERVICES COORD.  
*John J. Partridge*  
 THE MGR PROJECT ENGINEERING

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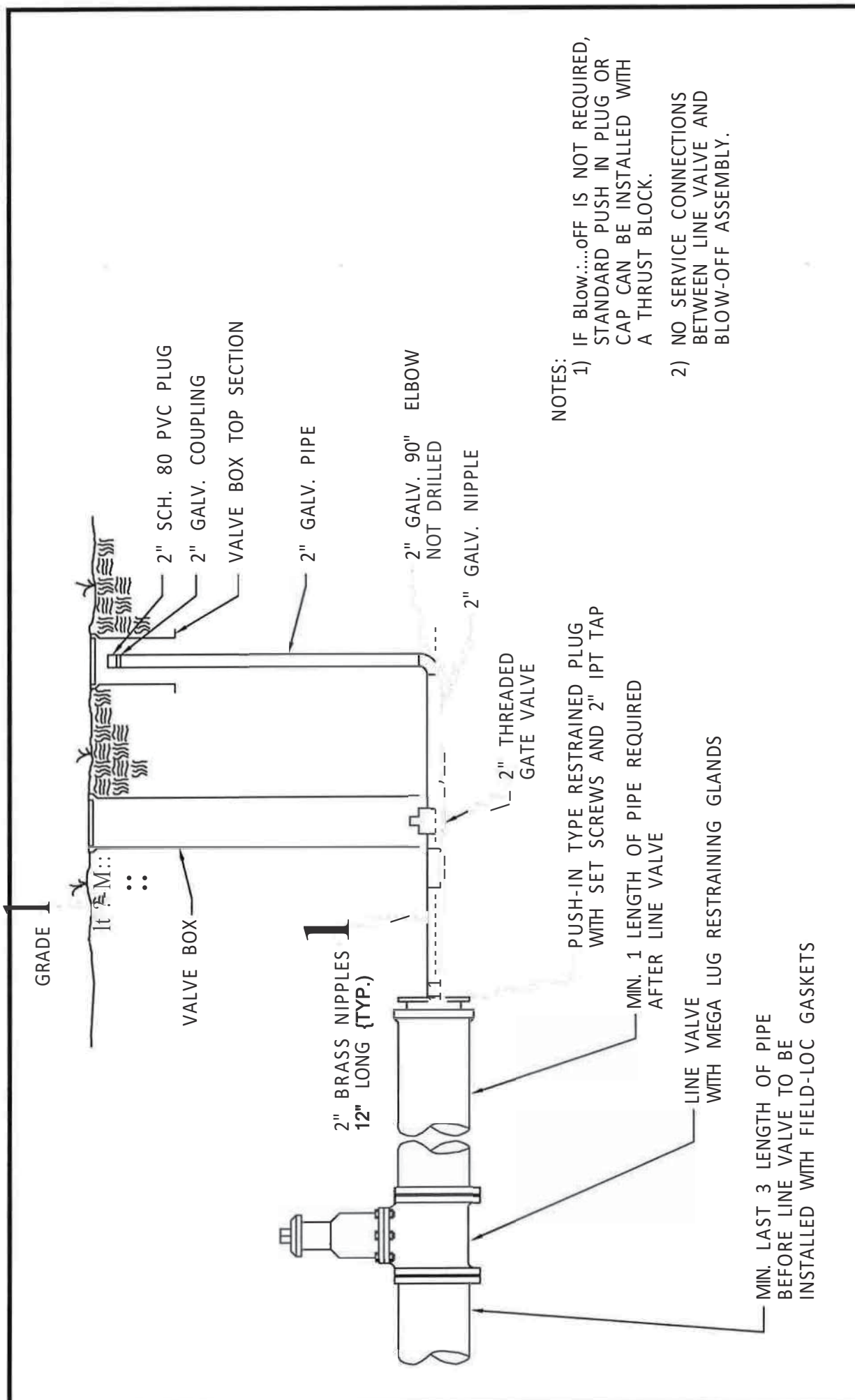
**HYDRANT INSTALLATION  
 DETAIL**

Scale: NTS

Drawing Number

**SD-4**

BU Number -  
 Sheet 1 of 1



NOTES:

- 1) IF BLOW-OFF IS NOT REQUIRED, STANDARD PUSH IN PLUG OR CAP CAN BE INSTALLED WITH A THRUST BLOCK.
- 2) NO SERVICE CONNECTIONS BETWEEN LINE VALVE AND BLOW-OFF ASSEMBLY.

PUSH-IN TYPE RESTRAINED PLUG WITH SET SCREWS AND 2" IPT TAP

MIN. 1 LENGTH OF PIPE REQUIRED AFTER LINE VALVE

LINE VALVE WITH MEGA LUG RESTRAINING GLANDS

MIN. LAST 3 LENGTH OF PIPE BEFORE LINE VALVE TO BE INSTALLED WITH FIELD-LOC GASKETS

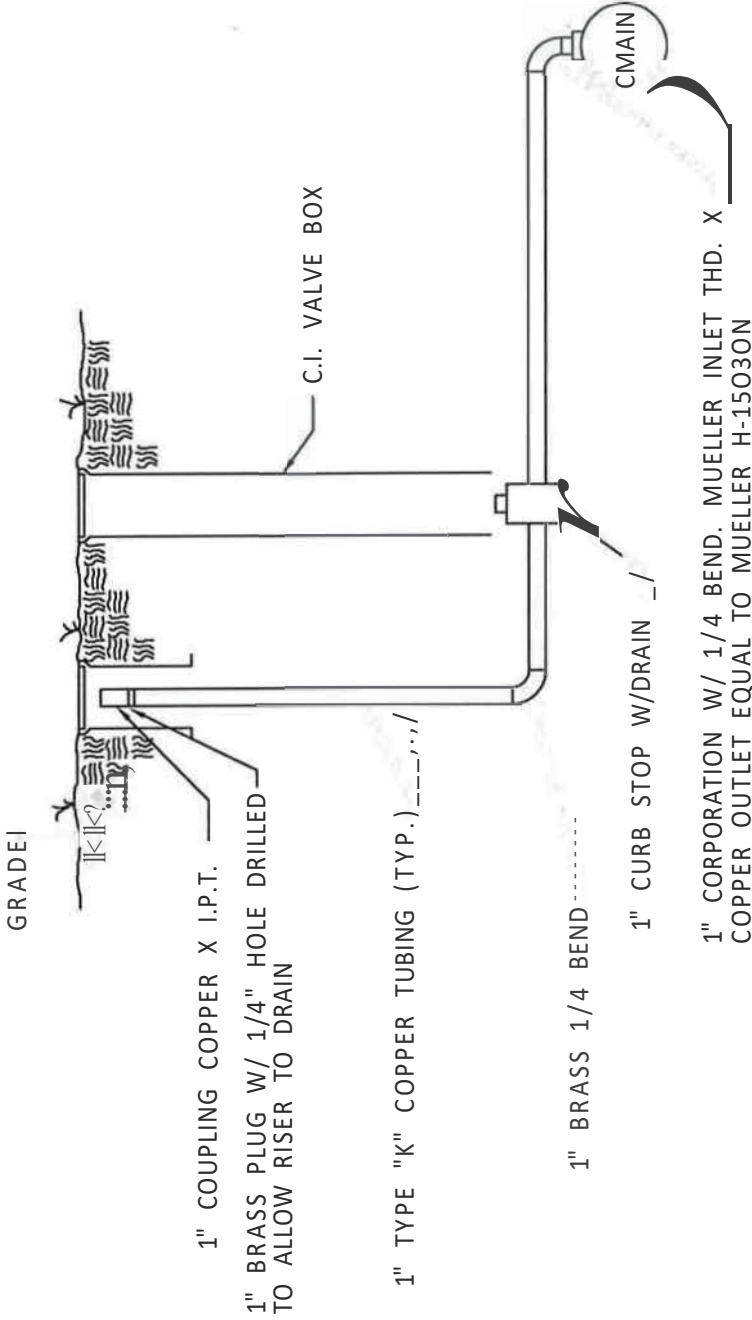
Drawn By: LRS/LMM  
 Date: 10/25/16  
 Approved by:  
*James J. Conroy*  
 THE REVEALER SERVICES COORD.  
 THE MGR. PROJECT ENGINEERING

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**4" - 12" WATER MAIN  
 DEAD END BLOW-OFF  
 DETAIL**

Scale: NTS  
 Drawing Number  
**SD-5**  
 BU Number -  
 Sheet 1 of 1

PROJECT NO.: BI-T-615



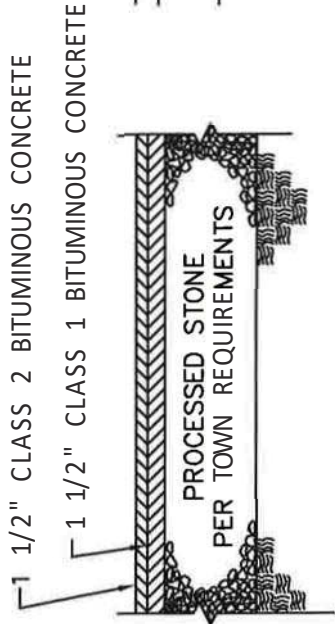
MANUAL AIR RELEASE VALVE

Drawn By: LRS/LMM  
 Date: 1/10/17  
 Approved by:  
*[Signature]*  
 THE DEVELOPER SERVICES COORD.  
 THE MGR. PROJECT ENGINEERING

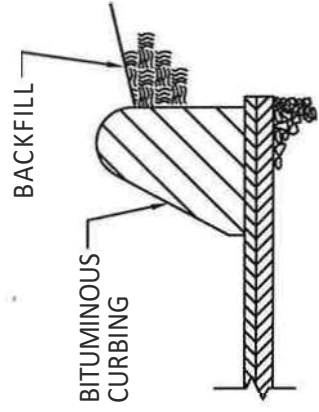
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 PROJECT NO.: BI-T-615

AIR RELEASE  
 DETAIL

Scale: NTS  
 Drawing Number  
**SD-6**  
 BU Number -  
 Sheet 1 of 1



**TOWN ROADS  
ASPHALT**

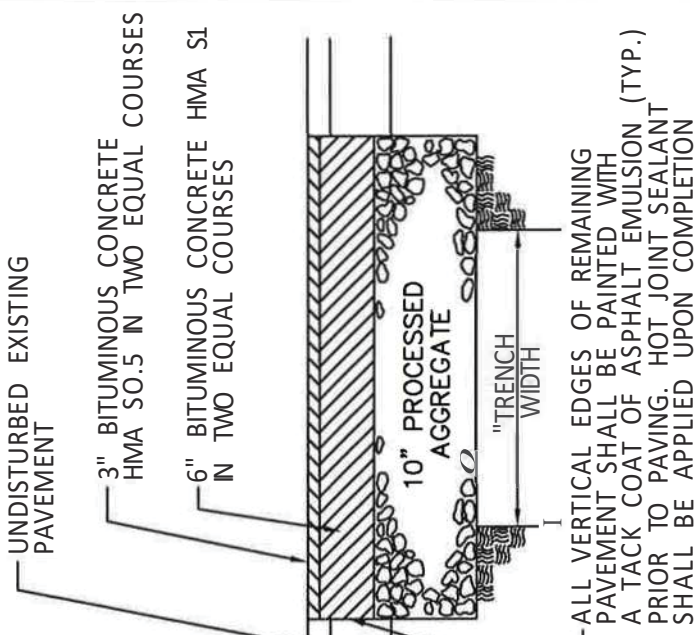


BITUMINOUS CONCRETE CURBING CONFORM TO DOT SPECIFICATION M:04:01 CLASS 3

**CURBING**

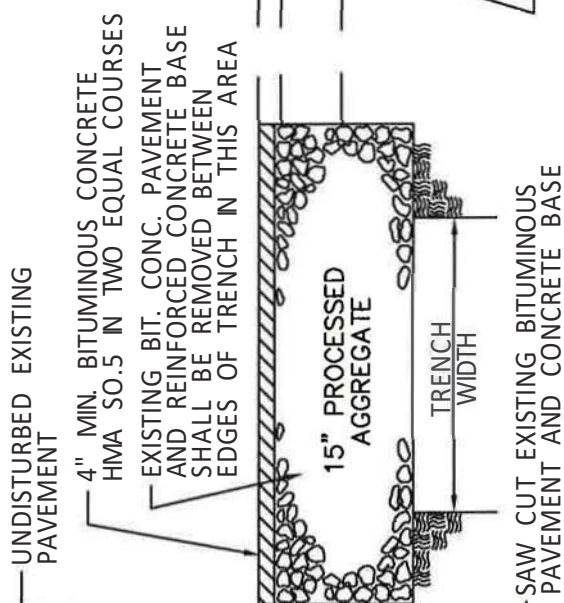
Construction Documents

3/13/2020



**PERMANENT TRENCH PAVEMENT**

**STATE ROADS  
ASPHALT**



**TEMPORARY TRENCH PAVEMENT**

NOTES:  
 1) DETAIL VARIES DUE TO INDIVIDUAL TOWN SPECIFICATIONS. DIMENSIONS MAY BE ALTERED DUE TO SPECIFIC REQUIREMENTS OF TOWN IN WHICH PROJECT IS LOCATED.  
 2) PROCESSED AGGREGATE AND BITUMINOUS CONCRETE PAVEMENT TO BE PER CURRENT D.O.T. SPECIFICATION.

Drawn By: LRS/LMM  
 Date: 3/3/17  
 Approved by: *[Signature]*  
 TRK DEVELOPER SERVICES COORD.  
 TRK MGR. PROJECT ENGINEERING



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PROJECT NO.: BI-T-615

**PAVEMENT DETAILS  
STATE AND TOWN  
ROADS**

Scale: NTS

Drawing Number

**SD-9**

BU Number -  
 Sheet 1 of 1



UNDISTURBED EXISTING PAVEMENT

LIMITS OF OVERLAY

10'

10'

SAW CUT EDGE AND APPLY BITUMINOUS TACK COAT WHERE NEW PAVEMENT MEETS WITH EXISTING; SEAL JOINT PER LATEST VERSION OF AASHTO M324 TYPE II (TYP.)

MILL EXISTING PAVEMENT ON BOTH SIDES OF PERMANENT PAVEMENT, AND MILL PERMANENT PAVEMENT TO A 2" DEPTH, AND OVERLAY WITH 2" MIN. COMPACTED THICKNESS OF BITUMINOUS CONCRETE HMA S0.5

10" PROCESSED AGGREGATE

TRENCH WIDTH

7" BITUMINOUS CONCRETE HMA S1 IN TWO EQUAL COURSES (9" INSTALLED PRIOR TO 2" MILL)

MILLING AND OVERLAY

TRENCHES PERPENDICULAR TO EDGE OF PAVEMENT

EDGE OF SHOULDER OR (t OF ROADWAY

LIMITS OF OVERLAY

MATCH EXISTING CROSS SLOPE

EDGE OF SHOULDER

MATCH EXISTING CROSS SLOPE

SAW CUT EDGE AND APPLY BITUMINOUS TACK COAT WHERE NEW PAVEMENT MEETS WITH EXISTING; SEAL JOINT PER LATEST VERSION OF AASHTO M324 TYPE II (TYP.)

MILL EXISTING PAVEMENT ON BOTH SIDES OF PERMANENT PAVEMENT, AND MILL PERMANENT PAVEMENT TO A 2" DEPTH, AND OVERLAY WITH 2" MIN. COMPACTED THICKNESS OF BITUMINOUS CONCRETE HMA S0.5

10" PROCESSED AGGREGATE

TRENCH WIDTH

7" BITUMINOUS CONCRETE HMA S1 IN TWO EQUAL COURSES (9" INSTALLED PRIOR TO 2" MILL)

MILLING AND OVERLAY

TRENCHES PARALLEL TO EDGE OF PAVEMENT

Drawn By: LRS/LMM

Date: 3 / 3 / 17

Approved by

*Samuel McPherson*  
THE DEVELOPER SERVICES CORP.  
THE MGR. PROJECT ENGINEERING

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PROJECT NO.: BI-T-615

Scale: NTS

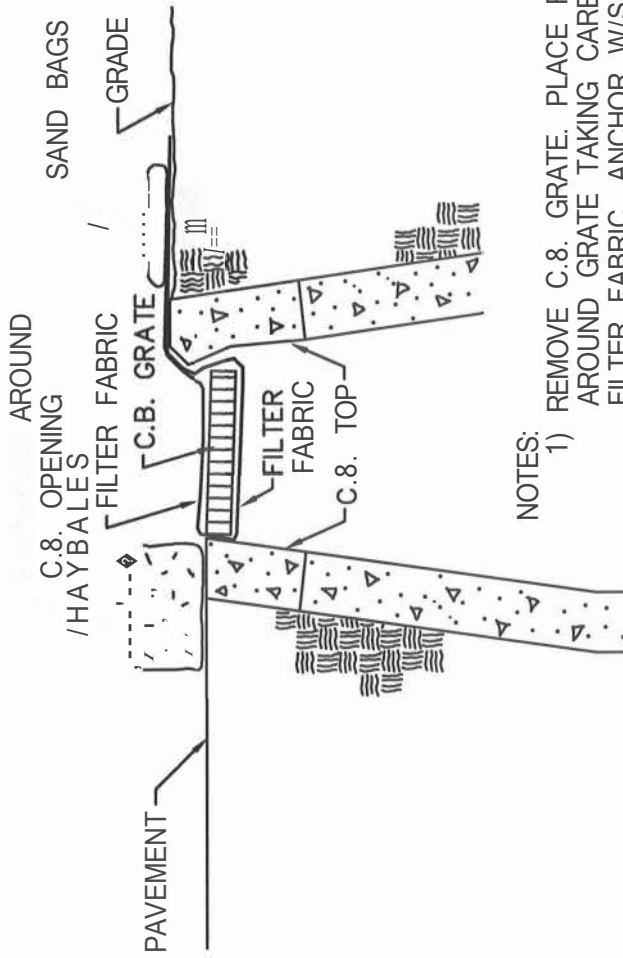
Drawing Number

**SD-9A**

BU Number -

Sheet 1 of 1

**PAVEMENT DETAILS  
STATE AND TOWN  
ROADS**



NOTES:

- 1) REMOVE C.8. GRATE. PLACE FILTER FABRIC AROUND GRATE TAKING CARE NOT TO DAMAGE FILTER FABRIC. ANCHOR W/SAND BAGS. PLACE HAY BALES IF REQUIRED.
- 2) SILT BARRIER REQUIRED ON ALL CATCH BASINS IN WORK AREA.

of  
 Construction Documents  
 15  
 2020

Drawn By: LLO

Date: 4/2/03

Approved by:

  
 TITLE CHIEF OF ENGINEERING

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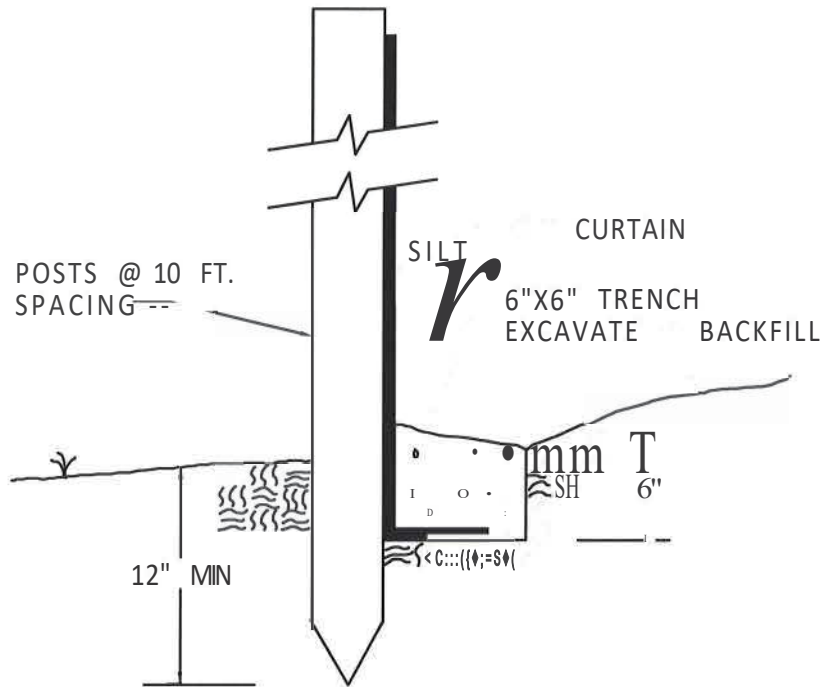
**CATCH BASIN  
SILT BARRIER  
DETAIL**

Scale: NTS

Drawing Number

**SD-10**

BU Number -  
 Sheet 1 of 1

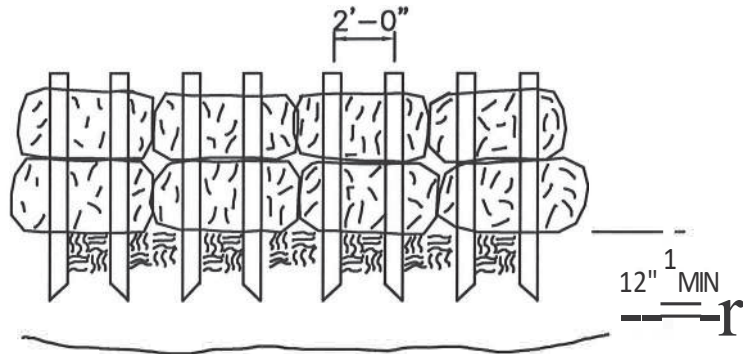


## SILT FENCE DETAIL

NOT TO SCALE

NOTES:

1. EXCAVATE TRENCH.
2. SECURE HAYBALES WITH TWO (2) STAKES.
3. BACKFILL AND COMPACT THE EXCAVATED SOIL ON THE UPHILL SIDE OF THE BARRIER.



## HAY BALE BARRIER DETAIL

NOT TO SCALE

Drawn By: LRS

Date: 4/2/03

Approved by:

TITLE CHIEF OF ENGINEERING

**Connecticut Water**  
 93 WEST MAIN STREET  
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 www.ctwater.com

### EROSION & SEDIMENT CONTROL DETAILS

Scale: NTS

Drawing Number

**SD-11**

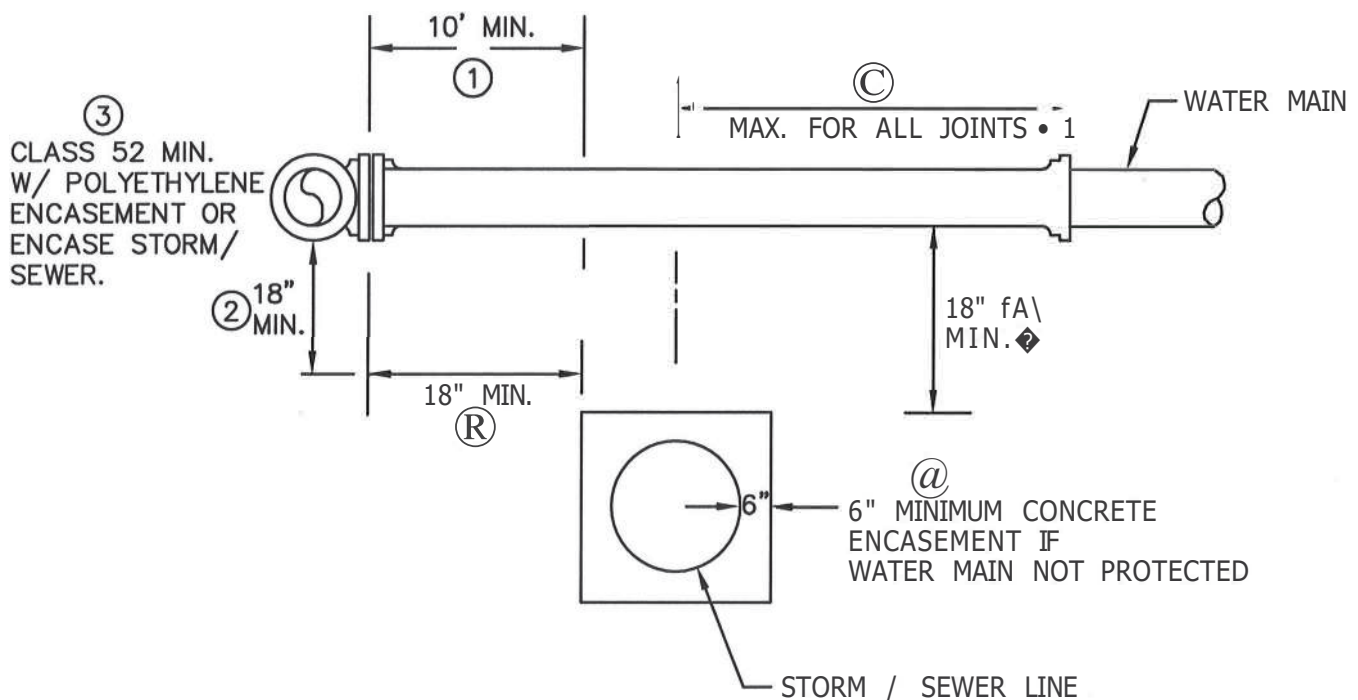
BU Number -

Sheet 1 of 1

PROJECT NO.: BT-605



- (D) WHENEVER POSSIBLE MAINTAIN A MINIMUM 10' SEPARATION FROM GRAVITY STORM OR SEWER LINES. ALWAYS MAINTAIN A MINIMUM 10' HORIZONTAL SEPARATION FROM FORCE SEWER MAIN.
- (R) IF 10' SEPARATION IS NOT POSSIBLE MAINTAIN A MINIMUM OF 18" HORIZONTAL SEPARATION WITH BOTTOM OF WATER MAIN A MINIMUM 18" ABOVE TOP OF STORM OR SEWER LINE
- (a) IF MINIMUM SEPARATION IS NOT POSSIBLE USE A MINIMUM CLASS 52 DUCTILE IRON PIPE WITH POLYETHYLENE ENCASEMENT, OR CONCRETE ENCASEMENT OF GRAVITY LINE
- (±) WHEN CROSSING GRAVITY LINES MAINTAIN A MINIMUM 18" VERTICAL SEPARATION WITH JOINTS SPACED AS FAR AS POSSIBLE FROM GRAVITY LINES



SEPARATION FROM  
STORM AND SEWER LINES  
DETAIL  
 NTS

Drawn By: LRS

Date: 4/27/07

Approved by:

Title:

Senior Engineer

**Connecticut Water**

93 WEST MAIN STREET  
 CLINTON, CT 06413-1600

www.ctwater.com

**SEPARATION FROM  
 STORM AND SEWER LINES  
 DETAIL**

Scale: NTS

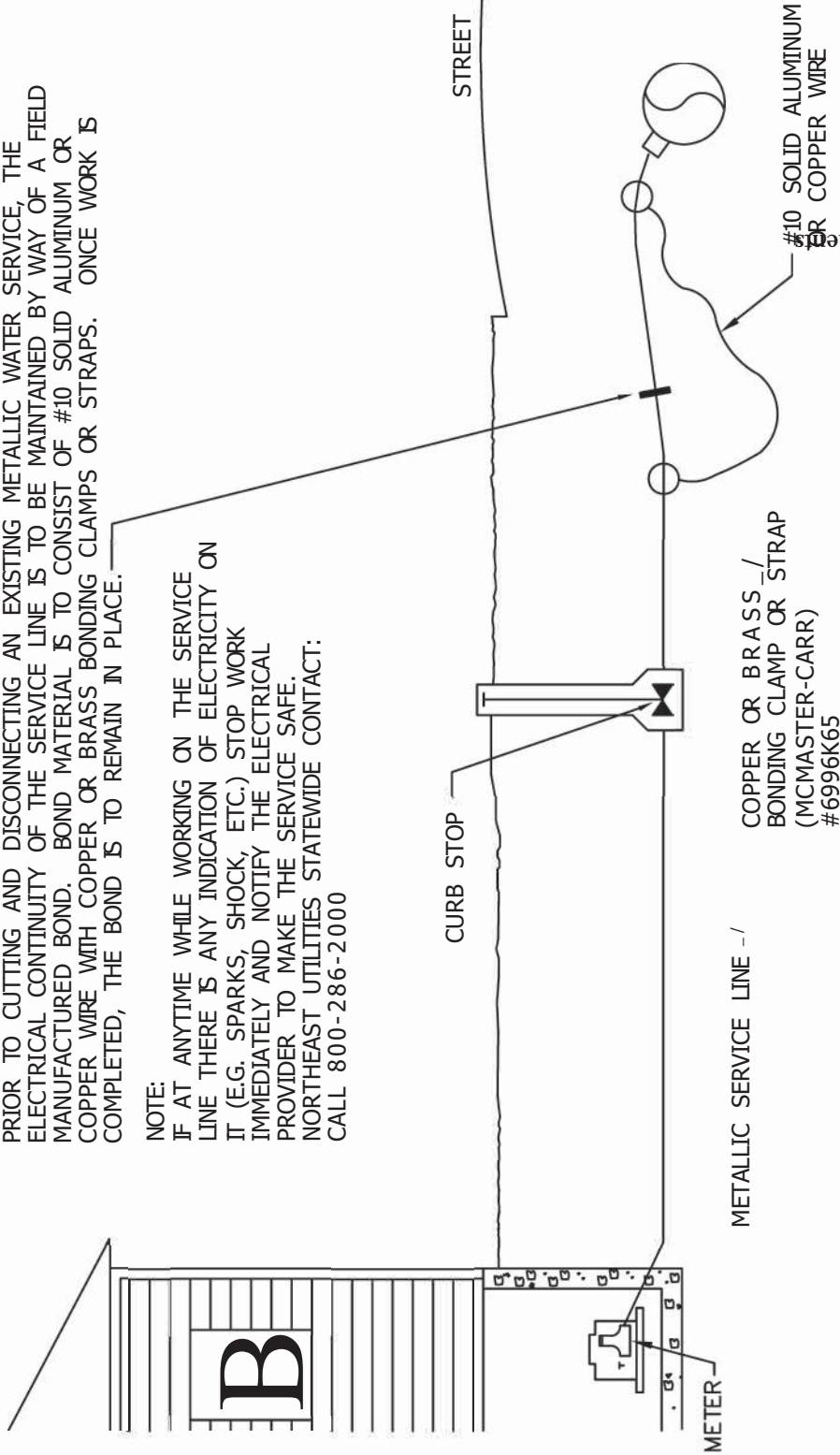
Drawing Number

**SD-22**

BU Number -  
 Sheet 1 of 1

PRIOR TO CUTTING AND DISCONNECTING AN EXISTING METALLIC WATER SERVICE, THE ELECTRICAL CONTINUITY OF THE SERVICE LINE IS TO BE MAINTAINED BY WAY OF A FIELD MANUFACTURED BOND. BOND MATERIAL IS TO CONSIST OF #10 SOLID ALUMINUM OR COPPER WIRE WITH COPPER OR BRASS BONDING CLAMPS OR STRAPS. ONCE WORK IS COMPLETED, THE BOND IS TO REMAIN IN PLACE.

NOTE:  
IF AT ANYTIME WHILE WORKING ON THE SERVICE LINE THERE IS ANY INDICATION OF ELECTRICITY ON IT (E.G. SPARKS, SHOCK, ETC.) STOP WORK IMMEDIATELY AND NOTIFY THE ELECTRICAL PROVIDER TO MAKE THE SERVICE SAFE. NORTHEAST UTILITIES STATEWIDE CONTACT: CALL 800-286-2000



Drawn By: CAL  
 Date: 11/7/07  
 Approved by: \_\_\_\_\_  
 Title: \_\_\_\_\_

**Connecticut Water**  
 93 WEST MAIN STREET  
 CLINTON, CT 06413-1600  
 www.ctwater.com

**WATER SERVICE  
 ELECTRICAL  
 BONDING PROCEDURE**

Scale: N.T.S.  
 Drawing Number  
**SD-23**  
 BU Number -  
 Sheet 1 of 1

Revision Document 09/2020

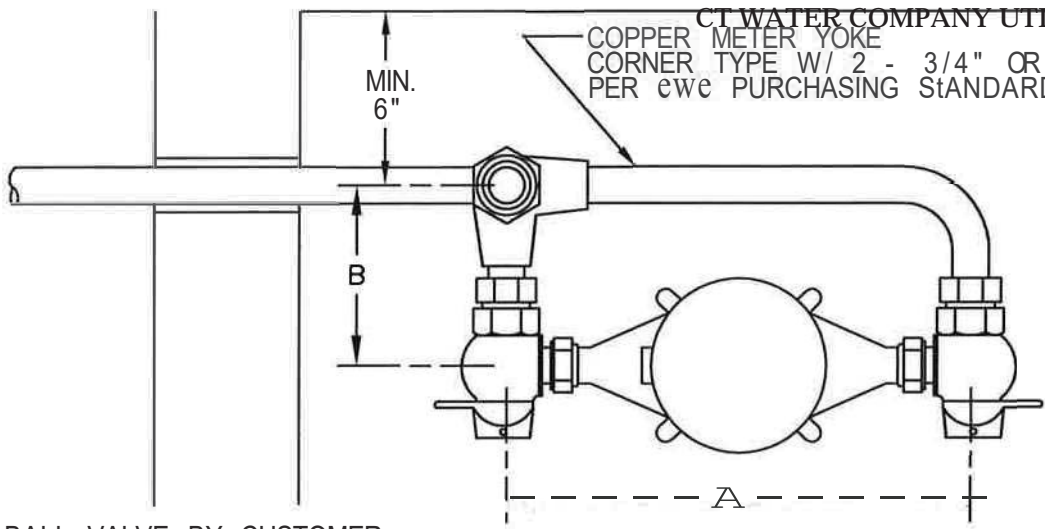


# STANDARD METER SETTINGS

- SMS-1 - STANDARD METER INSTALLATION FOR 5/8" X 3/4" TO 1" METER.
- SMS-2 - STANDARD METER INSTALLATION FOR 5/8" X 3/4" METERS WITH COMBINATION METERHORN AND PRESSURE REDUCING VALVE.
- SMS-3 - STANDARD METER PIT INSTALLATION FOR 5/8" X 3/4" & 3/4" METERS
- SMS-3A - STANDARD METER PIT INSTALLATION FOR 1" METERS
- SMS-3B - STANDARD SEASONAL METER PIT INSTALLATION FOR 5/8" & 3/4" METERS
- SMS-4 - STANDARD METER INSTALLATION FOR 1 1/2" METERS AND LARGER.
- SMS-5 - STANDARD METER PIT FOR 1 1/2" METERS AND LARGER.
- SMS-6 - STANDARD METER INSTALLATION FOR TWIN 2' METERS.
- SMS-7 - STANDARD METER PIT FOR TWIN 2' METERS.
- SMS-8 - STANDARD METER INSTALLATION FOR COMBINATION DOMESTIC AND IRRIGATION 5/8"x3/4" TO 1" METERS.

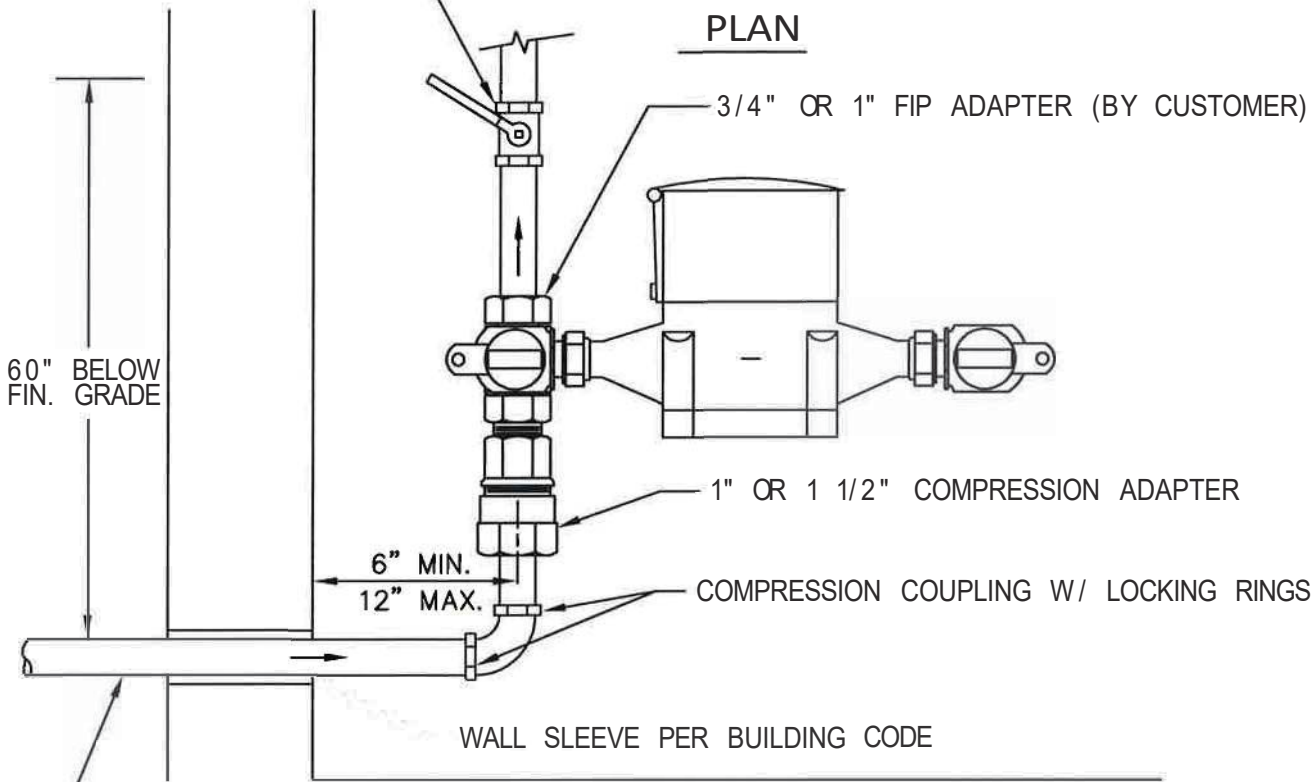
CT WATER COMPANY UTILITIES INSTALLATION

COPPER METER YOKE  
 CORNER TYPE W/ 2 - 3/4" OR 1" LOCKING ANGLE VALVES  
 PER ewe PURCHASING STANDARD



BALL VALVE BY CUSTOMER

PLAN

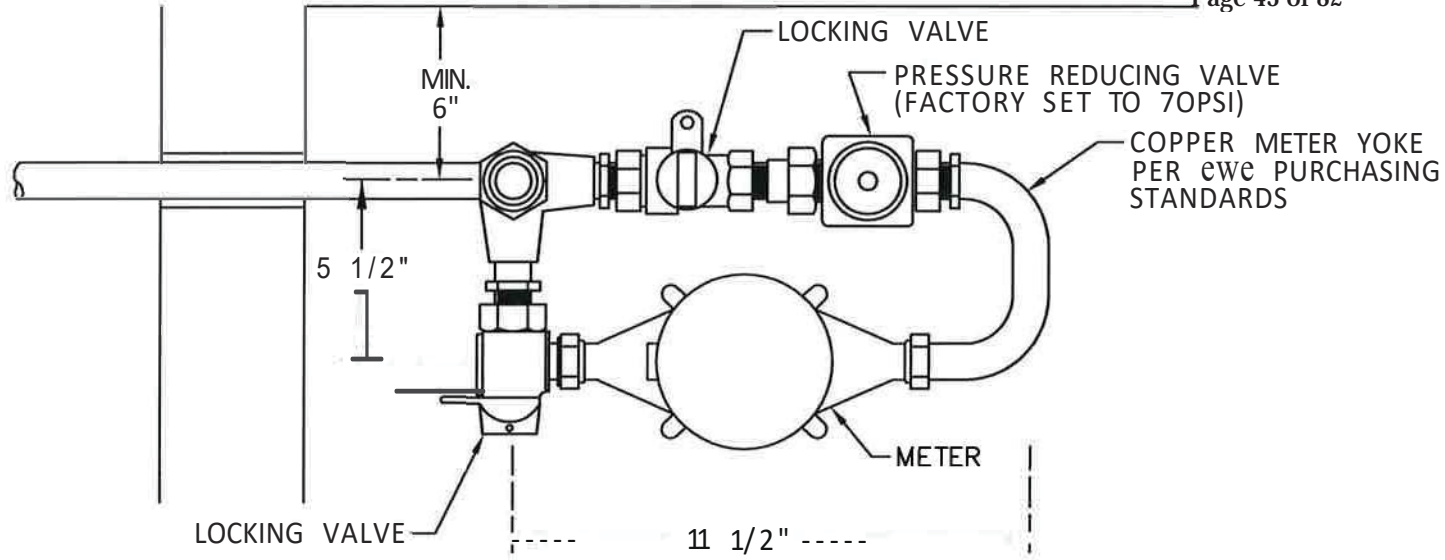


ELEVATION

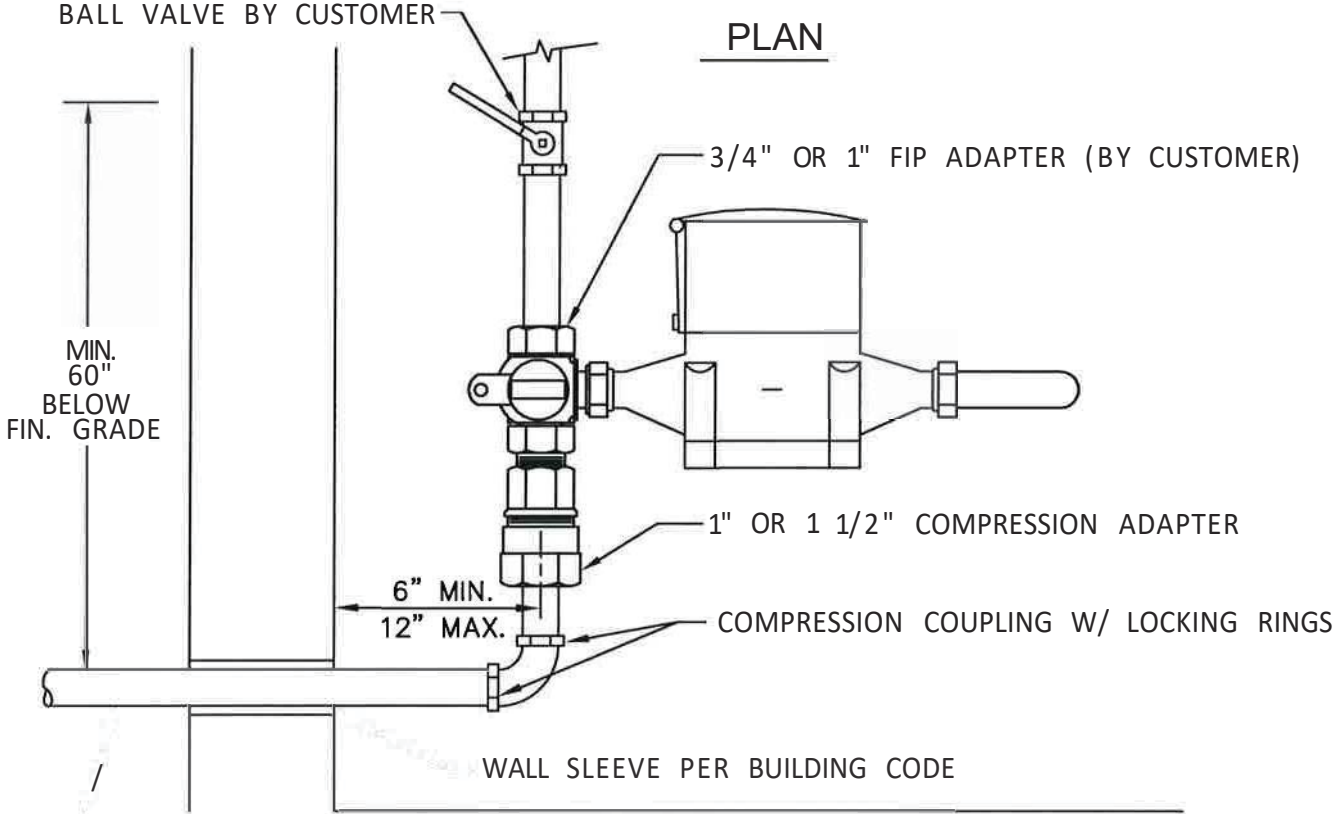
METER SIZE	DIM "A"	DIM "B"
5/8" X 3/4"	11 1/4"	4 1/2"
3/4"	12 3/4"	4 1/2"
1"	15"	5 1/2"

Revision	Description	Date	By	Approved By
Drawn By: LRS/LMM Date: 2/28/17 Approved by: <i>[Signature]</i> THE MGR. PROJECT ENGINEERING		Scale: NTS Drawing Number SMS-1 BU Number - Sheet 1 of 1		93 WEST MAIN STREET CLINTON, CT 06413 <b>Connecticut Water</b>

STANDARD METER  
 INSTALLATION  
 FOR  
 5/8" X 3/4" TO 1" METERS





PLAN

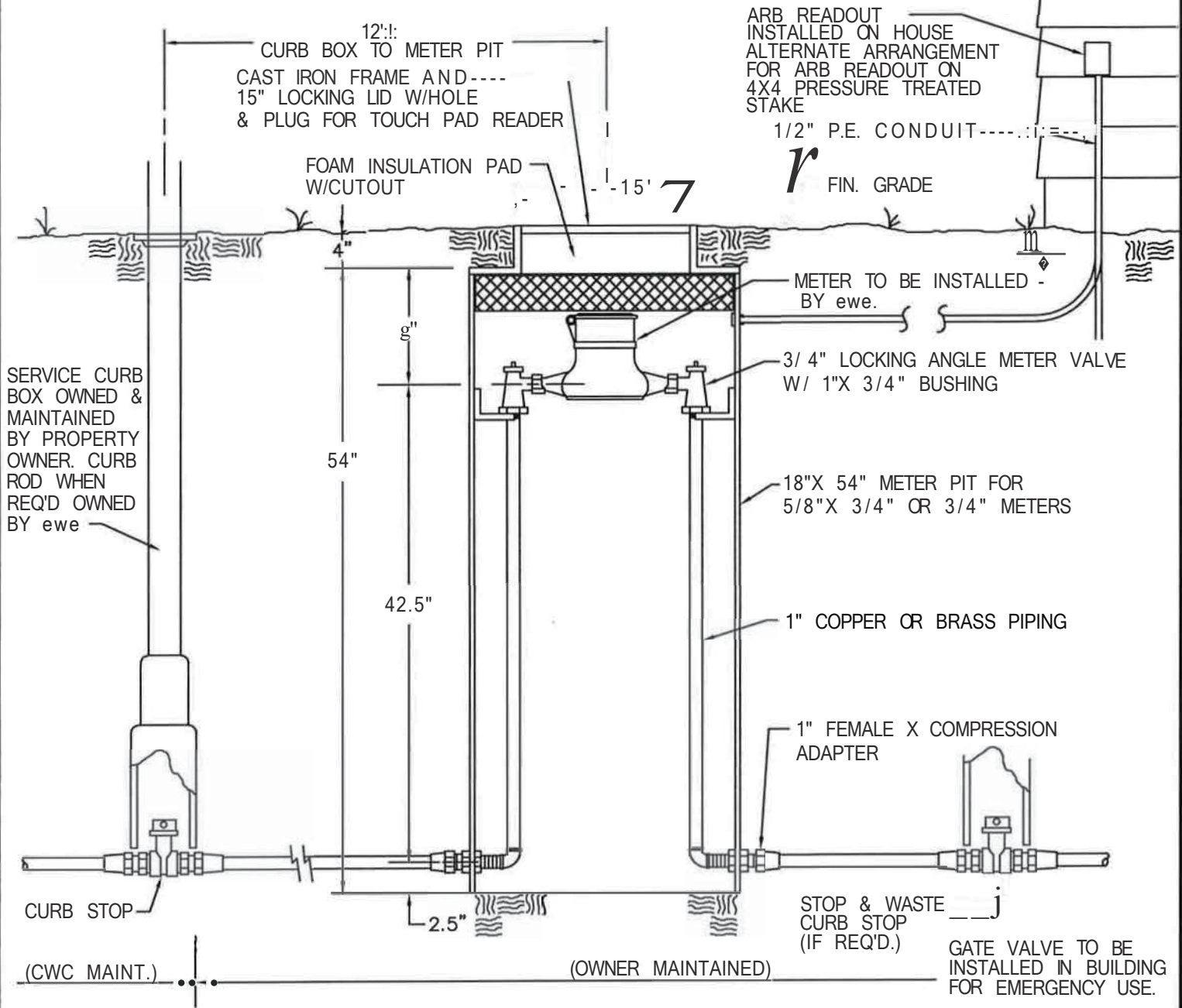


ELEVATION

Lcwc APPROVED srnv1cE uNE

Revision	Description	Date	By	Approved By	
Drawn By: LRS/LMM	 <p>93 WEST MAIN STREET CLINTON, CT 06413</p>	<p>STANDARD METER INSTALLATION FOR 5/8" X 3/4" METERS WITH COMBINATION METERHORN AND PRESSURE REDUCING VALVE</p>			
Date: 1/10/17					Scale: NTS
Approved by:  BRYAN MCDERMOTT THE DEVELOPER SERVICES COORD.					Drawing Number <b>SMS-2</b> BU Number - Sheet 1 of 1





SERVICE CURB BOX OWNED & MAINTAINED BY PROPERTY OWNER. CURB ROD WHEN REQ'D OWNED BY ewe

ARB READOUT INSTALLED ON HOUSE ALTERNATE ARRANGEMENT FOR ARB READOUT ON 4X4 PRESSURE TREATED STAKE

1/2" P.E. CONDUIT

FIN. GRADE

METER TO BE INSTALLED BY ewe.

3/4" LOCKING ANGLE METER VALVE W/ 1"X 3/4" BUSHING

18"X 54" METER PIT FOR 5/8"X 3/4" OR 3/4" METERS

1" COPPER OR BRASS PIPING

1" FEMALE X COMPRESSION ADAPTER

CURB STOP

STOP & WASTE CURB STOP (IF REQ'D.)



GATE VALVE TO BE INSTALLED IN BUILDING FOR EMERGENCY USE.

(CWC MAINT.)

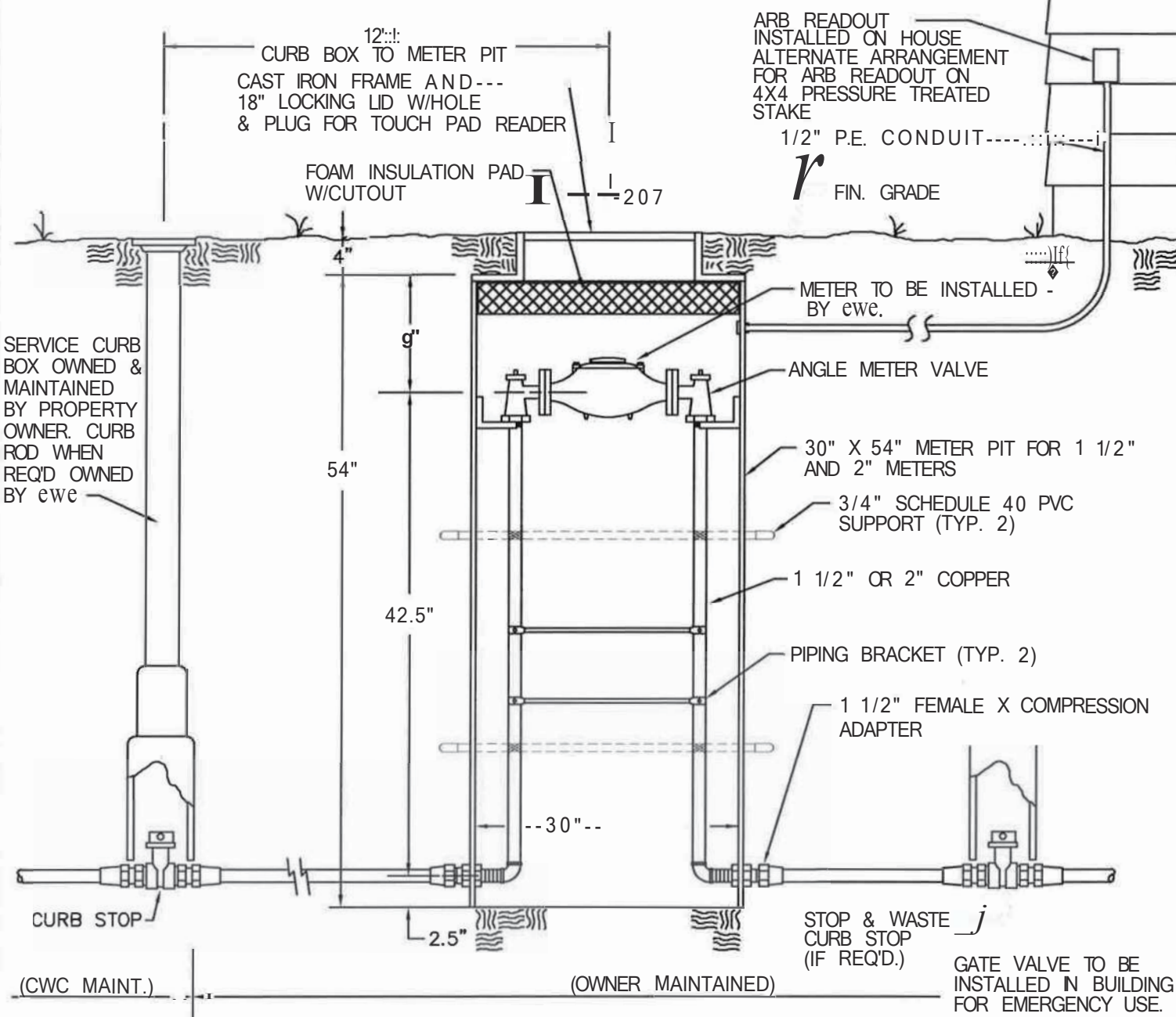
(OWNER MAINTAINED)

- NOTE:
- METER PITS TO BE INSTALLED ON SERVICE LINES LONGER THAN 150' OR IN SPECIAL INSTALLATIONS.
  - LOCATION OF METER PIT MUST BE APPROVED BY ewe

NOTE:  
THIS DRAWING REPLACES AMD-65

Drawn By: LRS/LMM	 <p>93 WEST MAIN STREET CLINTON, CT 06413</p>	<p>STANDARD METER PIT INSTALLATION FOR 5/8"X 3/4" OR 3/4" METER</p>	Scale: NTS
Date: 10/25/16			Drawing Number <b>SMS-3</b>
Approved by:  THE DEVELOPER SERVICES COORD. THE MGR. PROJECT ENGINEERING	BJ Number - Sheet 1 of 1		





- NOTE:
- 1.) METER PITS TO BE INSTALLED ON SERVICE LINES LONGER THAN 150' OR IN SPECIAL INSTALLATIONS.
  - 2.) LOCATION OF METER PIT MUST BE APPROVED BY ewe

NOTE:  
THIS DRAWING REPLACES AMD-66

Drawn By: LRS/LMM  
Date: 2/28/17  
Approved by:  
*[Signature]*  
THE DEVELOPER/SERVICES COORD.  
*[Signature]*  
THE MGR. ENGINEERING PROJECTS



STANDARD METER PIT  
INSTALLATION  
FOR  
1 1/2" AND 2" METERS

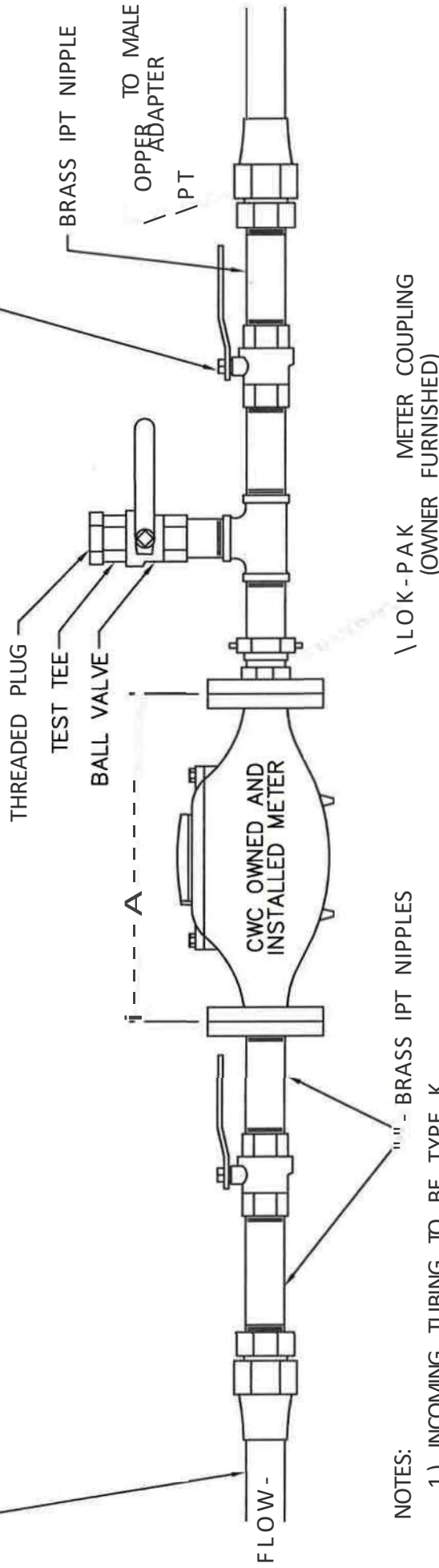
Scale: NTS  
Drawing Number  
**SMS-38**  
BU Number -  
Sheet of



METER SIZE	DIM. A
1 1/2"	13"
2"	17"
3"	12"

COPPER FOR 2" SERVICE AND BELOW WITH ADAPTER FOR IPT DUCTILE IRON FOR 4" SERVICE AND ABOVE WITH TAPPED PLUG FOR IPT

IPT BALL VALVE (TYP. 2 REQUIRED, ONE EACH SIDE OF METER)



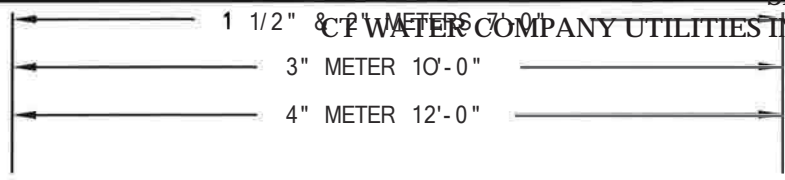
NOTES:

- 1.) INCOMING TUBING TO BE TYPE K COPPER OR CLASS 52 DUCTILE IRON OF APPROPRIATE SIZE AS APPROVED BY ewe.
- 2.) INSTALL A SEPARATE STRAINER FOR 3" & 4" METER INSTALLATIONS.

Revision	Description	Date	By	Approved By
Drawn By: LLO/LMM	STANDARD METER INSTALLATION FOR 1 1/2" METERS AND LARGER	Scale: N.T.S.		
Date: 1/10/17		Drawing Number SMS-4		
Approved by: <i>[Signature]</i> INC/DEVELOPER SERVICES COORD.	PROJECT NO.: BI-T-615			BU Number - Sheet 1 of 1

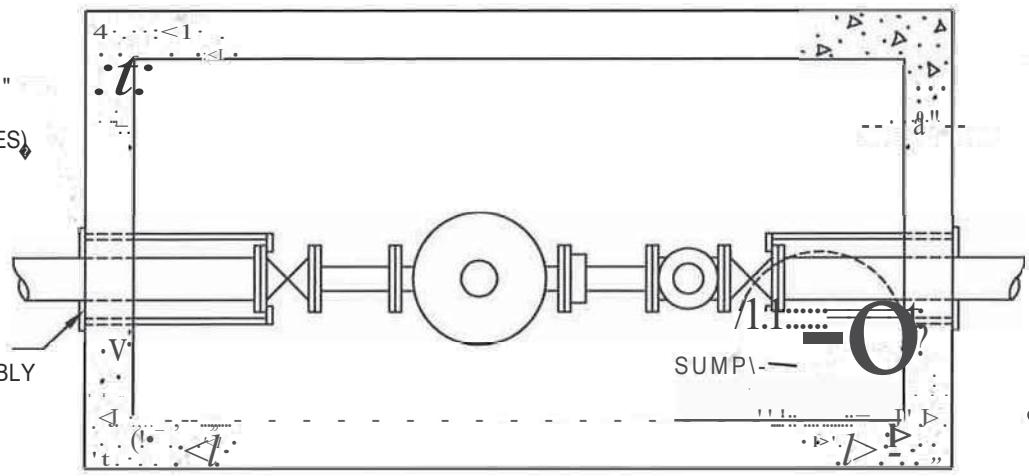


93 WEST MAIN STREET  
CLINTON, CT 06413



PIPE CLAMP W/2- 3/4" RODS TIED TO GATE VALVE (TYP. BOTH SIDES)

CAST IN PLACE SLEEVE AND LINK SEAL ASSEMBLY (SIZE AS REQ'D)



1  
0  
J

NOTES:

- 1.) H-20 DESIGN LOADING REQUIRED FOR CONCRETE PIT & COVER.
- 2.) INSTALL A SERERATE STRAINER FOR 3" & 4" METER INSTALLATIONS.

ALTERNATE ARRANGEMENT FOR ARB READOUT

#1012 5002 COVER ONLY HEAVY DUTY CAST ALUM.  
#1012 4512 6 1/2" FRAME ONLY CAST IRON  
CAMPBELL FOUNDRY

4X4 PRESSURE TREATED STAKE

ARB READOUT

APPROX. 30"

ARB REMOTE FOR METER READING

SOLID CONC. BLOCK, CAST IN PLACE, OR PRECAST CONCRETE

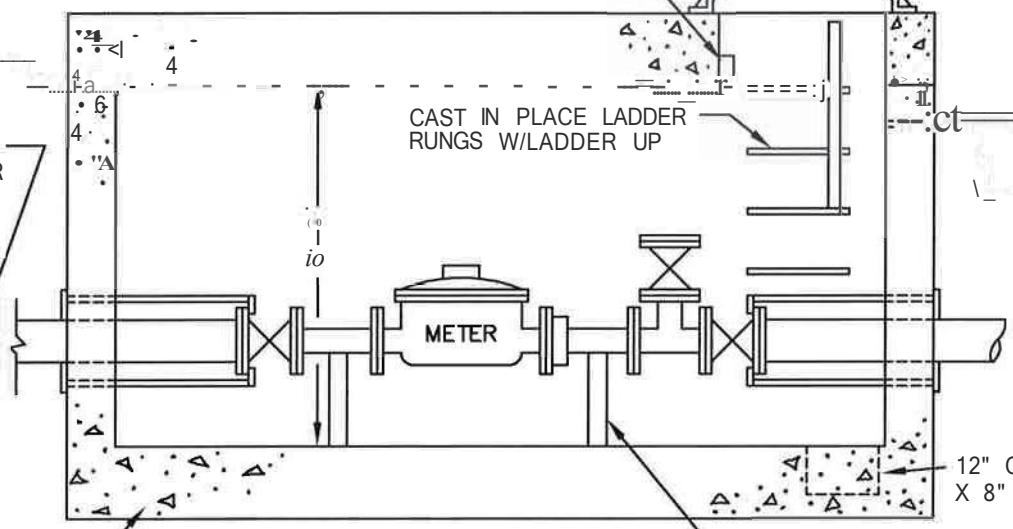
COPPER FOR 2" SERVICE & BELOW, WITH ADAPTER TO IPT.  
DUCTILE IRON FOR 4" SERVICE & ABOVE, WITH TAPPED PLUG FOR IPT TYP. BOTH SIDES

CAST IN PLACE LADDER RUNGS W/LADDER UP

1/2" THINWALL GALV. CONDUIT

FLOW----

GATE VALVE AT CURB LINE

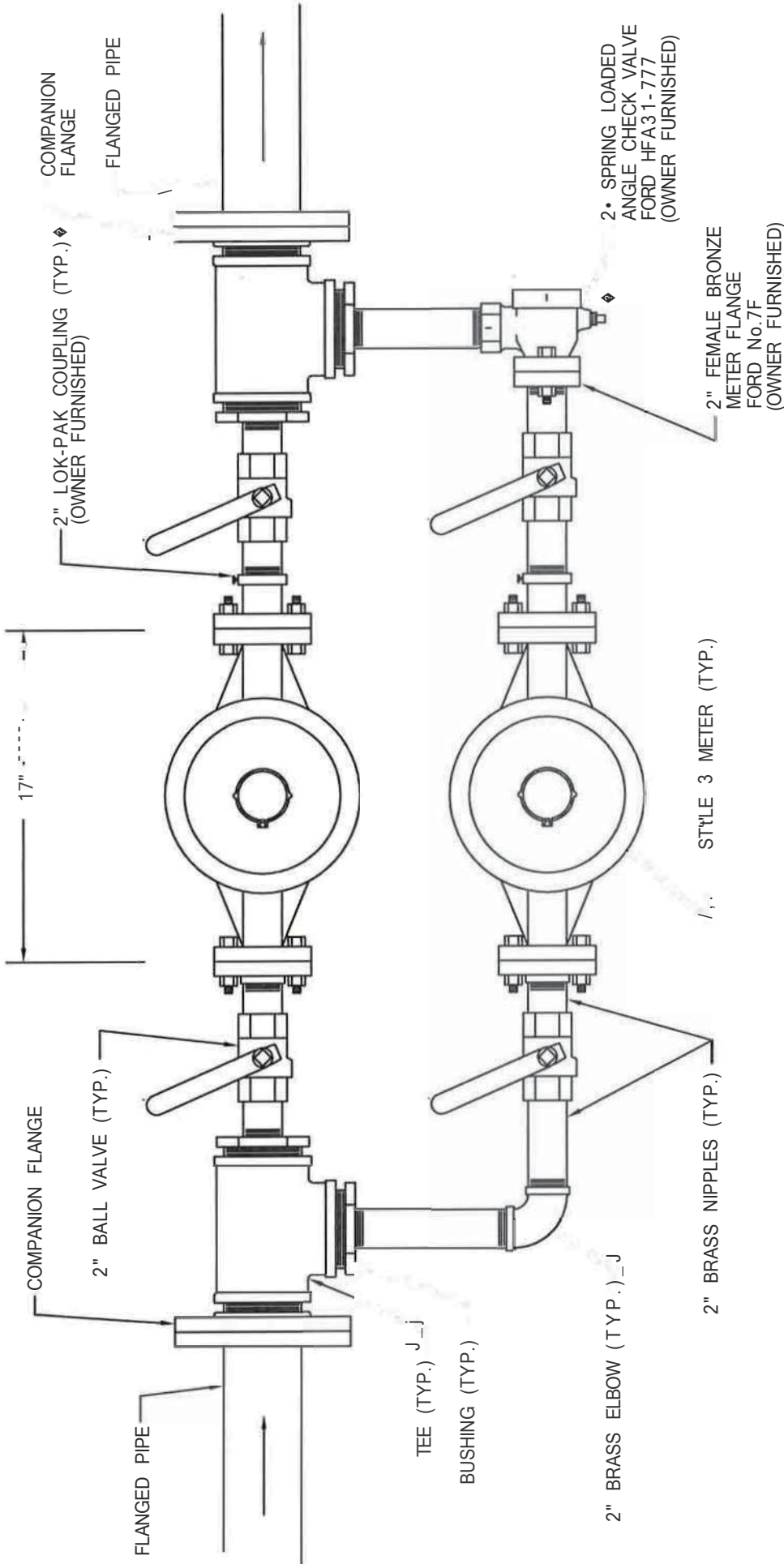


12" CIRCULAR X 8" DEEP SUMP

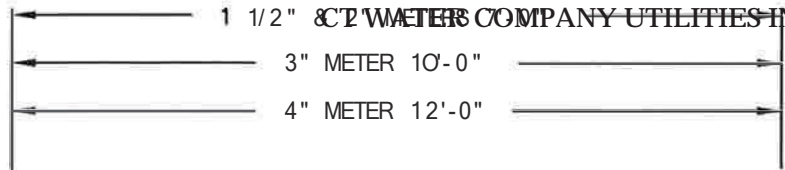
12" MIN. CONCRETE FLOOR  
ADDITIONAL THICKNESS OF FLOOR SLAB WILL BE REQ'D. IN AREAS OF HIGH GROUND WATER (LESS THAN 3 FEET BELOW GRADE).

CAST IN PLACE OR ADJUSTABLE GALV. PIPE SUPPORTS

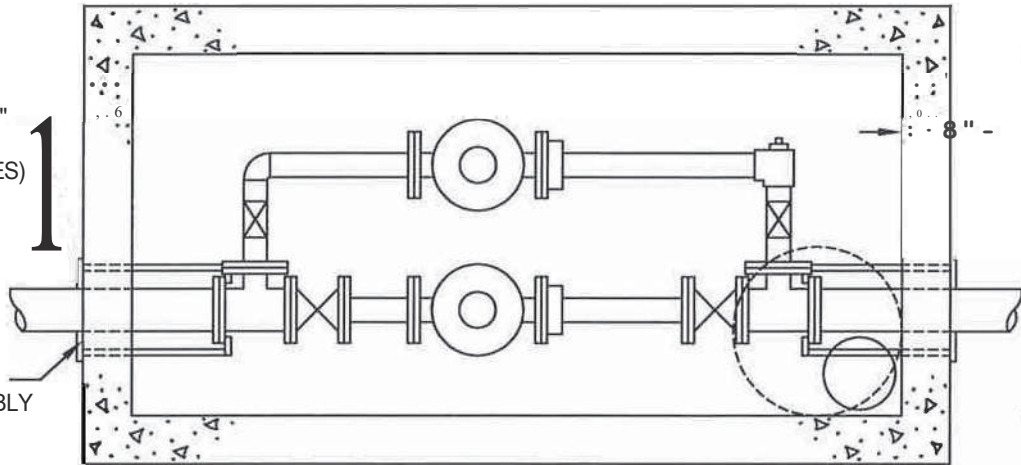
Revision	Description	Date	By	Approved By
Drawn By: LRS/LMM	<p>STANDARD METER PIT FOR 1 1/2" AND LARGER METERS</p>	Scale: NTS		
Date: 1/10/17		Drawing Number SMS-5		
Approved by:		BU Number - Sheet 1 of 1		
<p>93 WEST MAIN STREET CLINTON, CT 06413</p>		<p>PROJECT NO.: BI-T-615</p>		



Revision	Description	Date	By	Approved By
Drawn By: LRS/LMM	<b>Connecticut/Standard Meter Installation</b> <b>FOR TWIN 2" METERS</b>			
Date: 2128117		Scale: NONE		
Approved by: <i>[Signature]</i> THE DEVELOPER SERVICES CORP. THE MGR. PROJECT ENGINEERING	93 WEST MAIN STREET CLINTON, CT 06413 PROJECT NO.: BI-T-615	Drawing Number	SMS-6	
		BU Number -	Sheet 1 of 1	



PIPE CLAMP W/2- 3/4" RODS TIED TO GATE VALVE (TYP. BOTH SIDES)

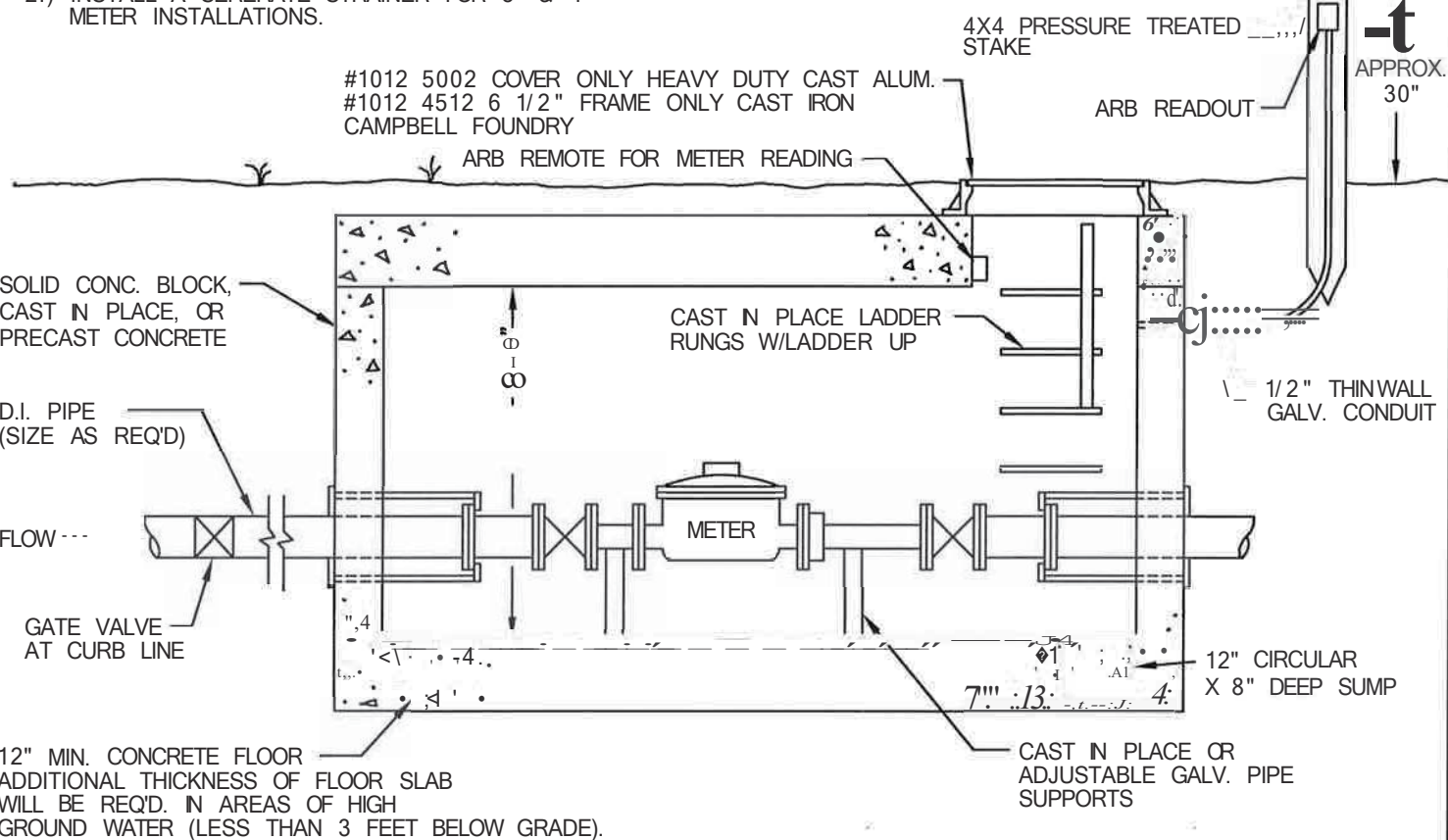


CAST IN PLACE SLEEVE AND LINK SEAL ASSEMBLY (SIZE AS REQ'D)

NOTES:

- 1.) H-20 DESIGN LOADING REQUIRED FOR CONCRETE PIT & COVER.
- 2.) INSTALL A SERERATE STRAINER FOR 3" & 4" METER INSTALLATIONS.

ALTERNATE ARRANGEMENT FOR ARB READOUT



SOLID CONC. BLOCK, CAST IN PLACE, OR PRECAST CONCRETE

D.I. PIPE (SIZE AS REQ'D)

GATE VALVE AT CURB LINE

12" MIN. CONCRETE FLOOR  
ADDITIONAL THICKNESS OF FLOOR SLAB WILL BE REQ'D. IN AREAS OF HIGH GROUND WATER (LESS THAN 3 FEET BELOW GRADE).

#1012 5002 COVER ONLY HEAVY DUTY CAST ALUM.  
#1012 4512 6 1/2" FRAME ONLY CAST IRON  
CAMPBELL FOUNDRY

4X4 PRESSURE TREATED STAKE  
ARB READOUT  
APPROX. 30"

CAST IN PLACE LADDER RUNGS W/LADDER UP

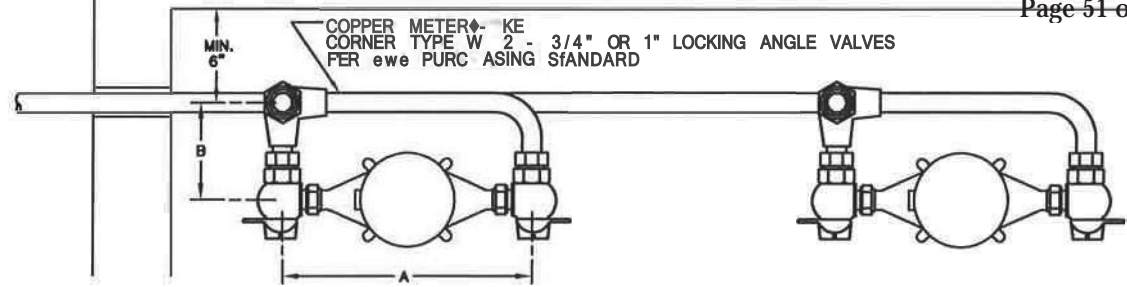
1/2" THIN WALL GALV. CONDUIT

12" CIRCULAR X 8" DEEP SUMP

CAST IN PLACE OR ADJUSTABLE GALV. PIPE SUPPORTS

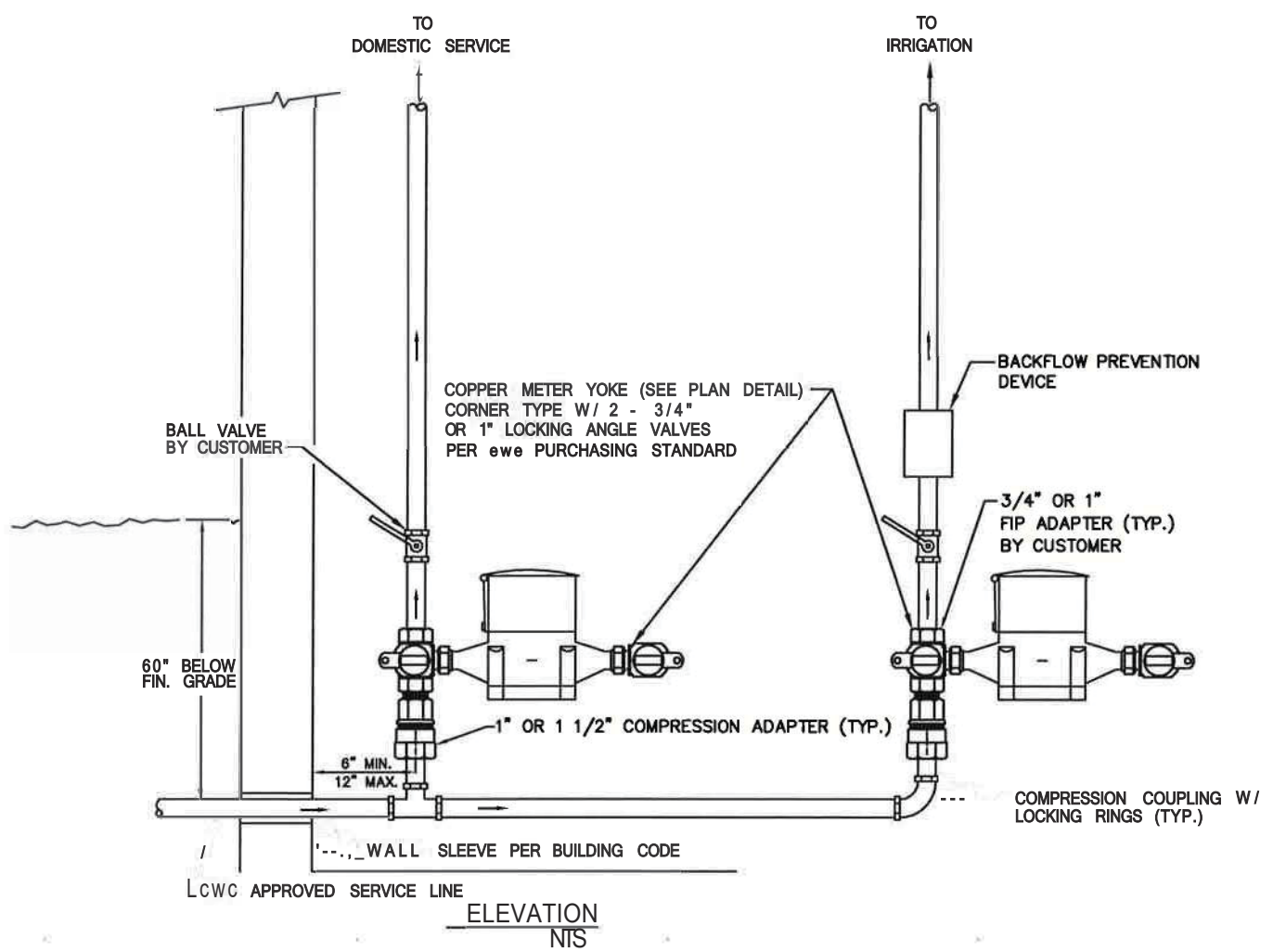
Revision	Description	Date	By	Approved By	
Drawn By: LRS/LMM		<p>STANDARD METER PIT FOR TWIN 2" METERS</p>			
Date: 2/28/17					Scale: NTS
Approved by:					Drawing Number: SMS-7
<p>93 WEST MAIN STREET CLINTON, CT 06413</p>		<p>BU Number - Sheet 1 of 1</p>			




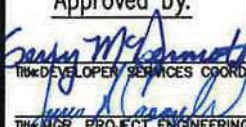


METER SIZE	DM "A"	DM "B"
5/8" X 3/4"	11 1/4"	4 1/2"
3/4"	12 3/4"	4 1/2"
1"	15"	5 1/2"

PLAN DETAIL  
STANDARD METER YOKE  
NTS



ELEVATION  
NTS

Revision	Description	Date	By	Approved By	
Drawn By: LRS/LMM	 <p>93 WEST MAIN STREET CLINTON, CT 06413</p>	<p>STANDARD METER INSTALLATION FOR COMBINATION DOMESTIC AND IRRIGATION 5/8" X 3/4" TO 1" METERS</p>			
Date: 2/28/17					Scale: NTS
Approved by:					Drawing Number
 <small>THE DEVELOPER SERVICES COORD.</small> <small>THE MGR. PROJECT ENGINEERING</small>		<p>SMS-8</p> <p>BU Number - Sheet 1 of 1</p>			

**Section X**  
**Polyethylene Encasement Installation Instructions**

# A STEP-BY-STEP GUIDE FOR INSTALLING POLYETHYLENE ENCASEMENT ON DUCTILE IRON PIPE

**T**HIS POLYETHYLENE SLEEVE (polywrap) is placed on ductile iron pipe to prevent corrosion. It does not interfere with the pipe's ability to be sealed watertight, but it should be installed so that no dirt or bedding material comes in contact with the pipe. All joints should be repaired before the pipe is wrapped with polyethylene. The repair should be made before the pipe is installed.

Small holes or tears will be repaired with a piece of tape placed over the hole. Large holes or tears should be repaired by taping anodized pipe at polyethylene encasement. The pipe can be held in place with tape or plastic ties & straps. The pipe should be installed in the trench.

Other general tips for proper installation include: • When lifting polywrap pipe with a badhoe, use a fabric-type "sling" or padjert cable in contact with the polyethylene. • When installing polywrap below the water table, use areas subject to soil drying, seal as thoroughly as possible with ends of each polyethylene time with adhesive tape or plastic tie straps at the joint. Also, place tape or plastic tie straps around the pipe at every 2 foot intervals. • Quality of installation is more important than the cost followed.

## FOLLOW THESE STEPS FOR EASY INSTALLATION



**STEP 1**  
Clean dirt, cinders, etc., from the surface of the pipe. Cut polyethylene two (2) foot lengths than the pipe. Slip polyethylene over spigot end and bunch as shown above.



**STEP 2**  
Dig bell holes at joint locations, lower pipe into trench and make up joint.



**STEP 3**  
Move cable hoist to bell end of pipe and lift end of pipe to slip polyethylene along trench above.



**STEP 4**  
Pull polyethylene from previous joint over the bell and secure in place as shown.



**STEP 5**  
Pull polyethylene from main pipe over this same bell, providing a double layer of polyethylene and secure in place as shown.



**STEP 6**  
Take up slack in the tube along the pipe barrel. Making a snug but not tight fit. Fold over on top of pipe and secure in place about every three (3) feet as shown.



**STEP 7**  
Make sure there are no tears in the polyethylene. If repaired, the pipe or another piece of polyethylene secured over the damaged area.



**STEP 8**  
Backfill the trench according to specifications, being careful not to damage the polyethylene while tamping around pipe. Backfill should not contain material that might damage the polyethylene.

### Hot Trench Installation



**STEP 1**  
Cut the polyethylene tube two (2) feet longer than pipe and slip over pipe as shown above.



**STEP 2**  
Spread the polyethylene tube as shown so that enough is left to provide a one (1) foot overlap at each end of pipe.



**STEP 3**  
Take up slack in the tube to make a snug but not tight fit and secure every four (4) foot with tape or plastic tie straps completely around the pipe.





**STEP 4**  
 When tapping pot is attached, be sure that the tapping hole is not damaged and make up joint. Make sure to seal the ends of polyethylene with tape or plastic tie.

### Tapping Pot-Wrapped Pipe

When tapping pot is attached, be sure that the tapping hole is not damaged and make up joint. Make sure to seal the ends of polyethylene with tape or plastic tie.



**STEP 1**  
 Wrap two or three layers of tape completely around the tapping pot. The tapping machine will be placed.



**STEP 2**  
 After the tapping machine is on the tapping area and the tapping hole is made, the tapping machine will be removed. The tapping machine will be removed.



**STEP 3**  
 Inspect the entire area for damage and repair if necessary.



**STEP 4**  
 Wrap and connect cover service line within three (3) feet of the pipe with polyethylene.

**STEP 5**  
 Backfill trench as described before.

Remember, if you have any problems or questions about installing polyethylene encasement, contact OIPRA or one of its member companies.

Call 1-800-368-5888 or visit our website at [www.oipra.com](http://www.oipra.com).  
 This information is provided for informational purposes only. It is not intended to constitute an offer of insurance or any other financial product. Please contact your agent for more information.

## DIPRA MEMBER COMPANIES

- American Cast Iron Pipe Company  
 P.O. Box 211  
 Birmingham, Alabama 35202-2727
- Atlantic States Cast Iron Pipe Union  
 183 St. Georges Street  
 Philadelphia, New Jersey 08106-3400
- Canada Pipe & Fittings Ltd.  
 1757 Burlington Street East  
 Hamilton, Ontario L8N 3R5 Canada
- Coastal Water Systems Corporation  
 P.O. Box 6001  
 Coshocott, Ohio 43812-6001
- Griffin Pipe Products Co.  
 1700 Opus Place, Suite 700  
 Downers Grove, Illinois 60515-5707
- McWane Cast Iron Pipe Company  
 1201 Vandebilt Road  
 Birmingham, Alabama
- Padoc States Cast Iron Pipe Company  
 P.O. Box 11219  
 Provo, Utah 84602-1219
- United States Pipe and Foundry Company  
 P.O. Box 1  
 Birmingham, Alabama 35202-0001

## DUCTILE IRON PIPE RESEARCH ASSOCIATION

The association of quality producers dedicated to the highest pipe standards through a program of continuing research.  
 245 Riverside Parkway East, Suite 0  
 Birmingham, Alabama 35214-1866  
 Telephone: 205-402-0000 FAX: 205-402-5130  
<http://www.oipra.com>

## DUCTILE IRON PIPE THE RIGHT DECISION

100% Recycled from recycled material.

# POLYETHYLENE ENCASEMENT INSTALLATION GUIDE

Effective, Economical Protection for Ductile Iron Pipe In Corrosive Environments







**DISINFECTION and FLUSHING**

Prior to any section of pipeline being put into service, it shall be thoroughly disinfected in accordance with AWWA Standard C651-14, AWWA Standard for Disinfecting Water Mains, Section 4.4, Continuous-Feed Method of Chlorination (or the latest revision thereof) included as Appendix AA.

The Contractor is responsible for developing a detailed plan for the disinfection procedure with liquid sodium hypochlorite solution (conforming to ANSI/AWWA B300) and de-chlorination of discharge water for the water main installation. The detailed plan shall be submitted to the Company for approval. This submittal should identify the location of injection and discharge points, the materials (conforming to Company specs) and disinfection and de-chlorination products to be used. This submittal shall also identify any proposed subcontractors for this activity and provide references (3) and list of comparable projects (3) recently completed by them. The contractor shall only proceed with this procedure upon approval of the submittal by the Company.

The Company will typically perform the flushing of the water main in preparation for disinfection. As needed the contractor shall support the Company with this effort to meet the following guidelines. The completed line shall be slowly filled with water to eliminate air pockets and flushed to remove particulates. The flushing velocity in the main shall not be less than 3.0 ft/sec (0.91 m/sec). Flushing shall be performed for a sufficient period of time to allow for a minimum of 3 volume changes of water in the main (approximately 16 minutes per 1,000 feet of main at a flow rate that produces 3.0 ft/sec rate).

Introduce chlorine to the main at a constant rate from a point not more than 10 ft. downstream from the beginning of the new main, such that the water will have at least 25 mg/L free chlorine. The heavily chlorinated main shall remain at static pressure for no less than 24-hrs. (not to exceed 48-hrs.). Chlorine residual remaining after 24 hours must be at least 10 mg/L. If less than 10/mg/L chlorine is measured after 24 hours, the Contractor shall repeat flushing and disinfection procedures.

**Flushing and Dosing Reference Values**  
 (From AWWA C651 Table 3 and Table 4)

Pipe Diameter (in)	Flushing Flow Rate to Produce 3.0 ft./sec (gpm)	1% Chlorine Solution Required to Produce 25 mg/L concentration in 100 feet of pipe (gal)
4	120	0.16
6	260	0.36
8	470	0.65
12	1,060	1.44

The Contractor shall be responsible for the dechlorination of disinfection discharge water. The discharge of heavily chlorinated water (concentrations greater than system residual) to the

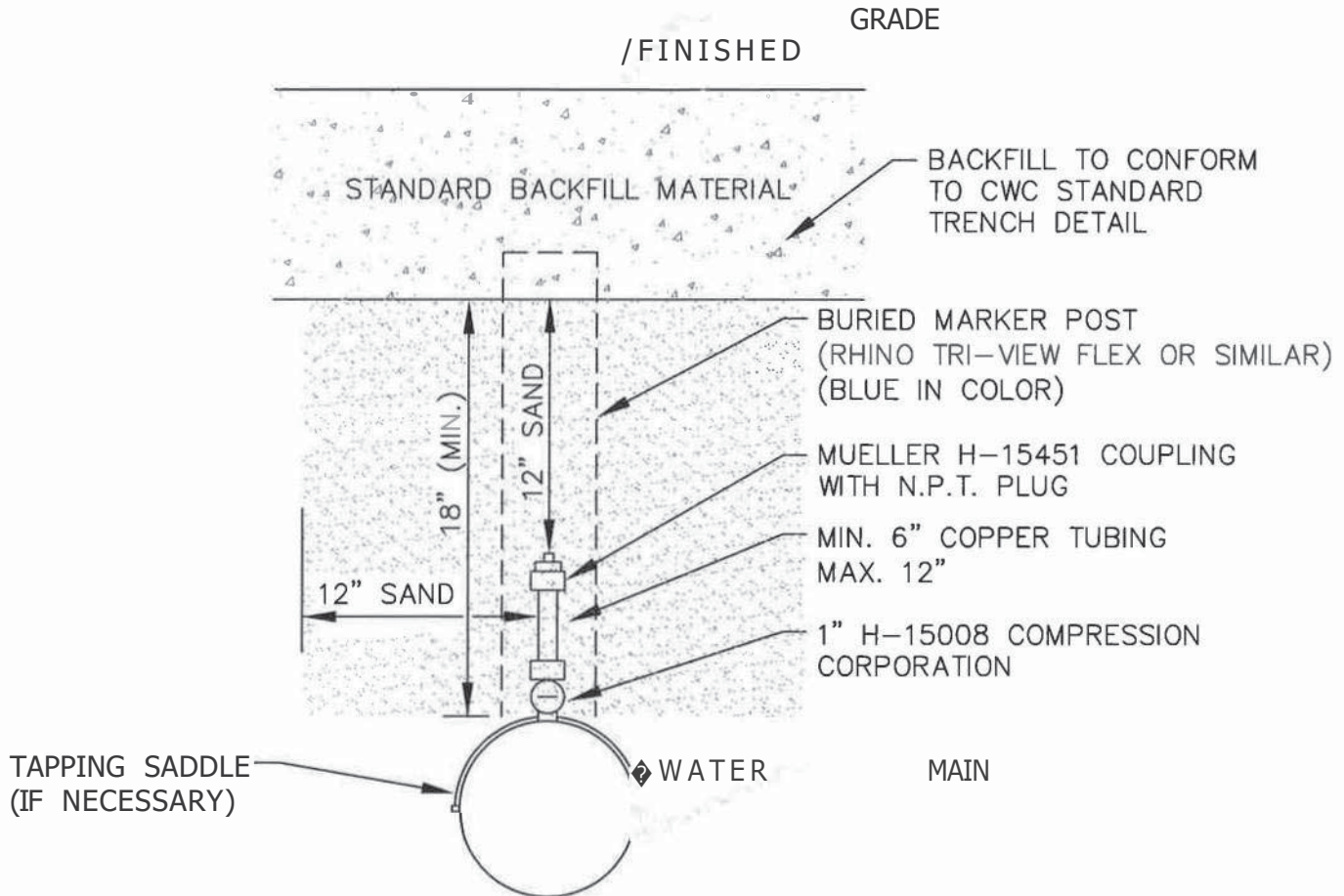


environment is prohibited. The discharge water must be dechlorinated satisfactory to the Company before released to the environment. Dechlorination will be incidental to the activity. During dechlorination, a neutralizing chemical shall be applied to the water to be wasted to thoroughly neutralize the residual chlorine (see ANSI/AWWA C655 for neutralizing chemicals). Where necessary, federal, state, local, or provincial regulatory agencies should be contacted to determine special provisions for the disposal of heavily chlorinated water.

Upon completion of flushing, disinfection, and dechlorinating, a water sample from the section shall be collected by the Company for third-party analysis.

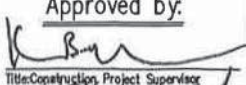


No section of main shall be put into service without the approval of the Company, and should the analysis be unsatisfactory, the section shall again be disinfected and retested until an analysis satisfactory to the Company is obtained. All costs for additional disinfection and retesting shall be borne by the Contractor. All temporary taps and discharge points for the disinfection and flushing process shall be permanently abandoned upon successful testing unless approved by the Company to stay in place. Abandonment of temporary taps includes positioning the corporation 'off' and installing a Mueller H-15451 coupling and corresponding NPT plug. Abandonment of disinfection taps and blow-offs will be incidental to the activity and shall be coordinated with the Company representative.

See Attached Standard Details SD-27 & SD-28 for Abandonment Detail & Chlorination Blow Off Detail.

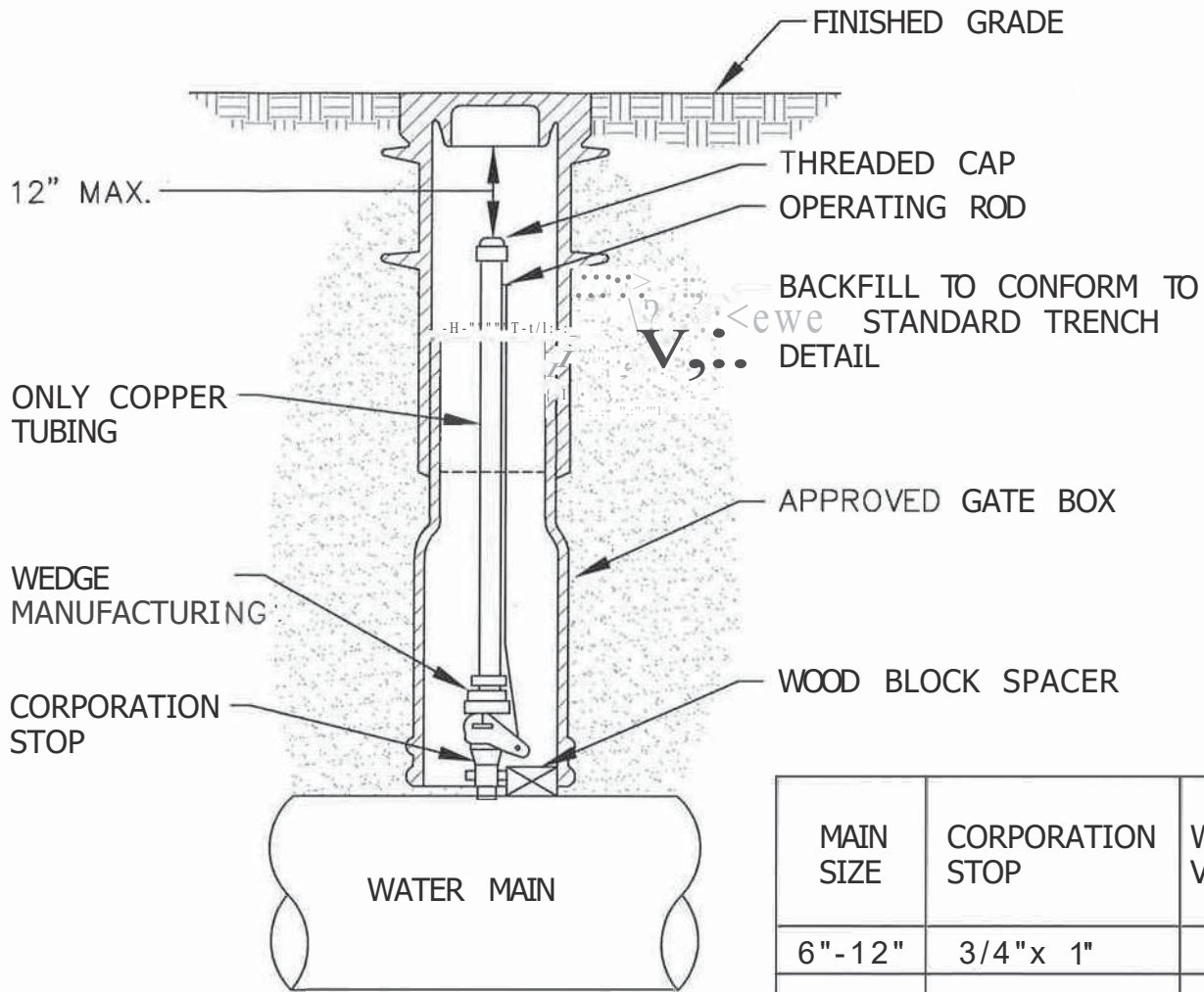


# WATER SERVICE ABANDONMENT DETAIL

N.T.S.

Revision	Description	Date	By	Approved By
Dawn By: FHG Date: 1/15/19 Approved by:  <small>Title: Construction Project Supervisor</small>  <small>Title: Construction Documents</small>		 93 WEST MAIN STREET CLINTON, CT 06413-1600 www.ctwater.com		Scale: N.T.S. Drawing Number <h2 style="margin: 0;">SD-27</h2> BU Number - PROJECT NO. BLT-615 Sheet 1 of 1
<h2 style="margin: 0;">WATER SERVICE ABANDONMENT DETAIL</h2>		PROJECT NO. BLT-615 Sheet 1 of 1		

5/15/2020




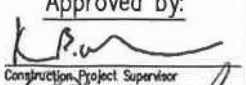

MAIN SIZE	CORPORATION STOP	WEDGE VALVE
6"-12"	3/4"x 1"	1"
16"-42"	1 1/2"x-2"	2"

NOTES:

- 1). CANNOT BE USED AS FUTURE CUSTOMER SERVICE CONNECTION.
- 2). A CHLORINATION/SAMPLING ASSEMBLY SHALL BE REMOVED (\*SEE SD-27) ONCE WATER MAIN PASSES SAMPLING. CORPORATION SHALL EITHER BE CONVERTED TO AIR VALVE OR ABANDONED PRIOR TO FINAL PAVEMENT RESTORATION.

CHLORINATION INLET/BLOW-OFF DETAIL

N.T.S.

Revision	Description	Date	By	Approved By
Drawn By. FHG	 93 WEST MAIN STREET CLINTON, CT 06413-1600 www.ctwater.com	CHLORINATION INLET/BLOW-OFF DETAIL		
Date: 1/15/19				
Approved by:  Construction Project Supervisor  Infrastructure Rehabilitation	Scale: N.T.S. Drawing Number <b>SD-28</b> BU Number - PROJECT NO. BLT-615 Sheet 1 of 1			



***CONNECTICUT WATER SERVICE***

***PURCHASING STANDARDS  
FOR  
WATERWORKS MATERIAL***

***FOR ALL SUBSIDIARY COMPANIES***

***JANUARY 2019***



## **FORWARD**

The purpose of Purchasing Standards for Waterworks Materials is to identify a set of materials that provide reliable service at reasonable life cycle cost under the range of conditions and over the life expected of the Company's distribution systems. This edition includes substantial updates of the AWWA Standard references, a careful review of each item included and meter installation drawings.

The choices include the collective consideration of Connecticut and Maine Water Company's (MWC) Operations, Field Service, Construction, Engineering and Procurement personnel. Connecticut Water Company also includes the recently acquired Heritage Village and Avon Water Companies and will be collectively referred herein as CWC.

Utility experience, availability, material design factors, design life, standardization for repair replacement and spares are all part of the evaluation process for the regular use of these materials. Installations involving above or below grade crossings, high operating pressure, corrosive and/or contaminated or suspected contaminated soils and for other special service conditions or use of non-standard materials, consult with the Engineering Group to confirm a selection that is appropriate and approved for the project or duty.

**All material supplied to and used by CWC/MWC is to be manufactured in the USA or Canada and must be in accordance with the American Iron and Steel Act. Any specific exceptions must be given by CWC/MWC.**

**CWC/MWC reserves the right to reject some or all of any material delivered should there be any deficiencies in our quality inspection.**

**All brass items shall conform to the "Lead Free Brass Standards" as approved by the AWWA.**

**These specifications dated January 18, 2019 shall supersede all previous published documents.**



PURCHASING STANDARDS FOR WATERWORKS MATERIAL

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## WATER MAIN MATERIALS

### DUCTILE IRON PIPE

Pipe shall be minimum thickness Class 52 or pressure class 350 ductile-iron as specified per installation location, double cement mortar-lined, double bituminous seal coated inside, manufactured and finished in The United States of America or Canada and in accordance with ANSI/AWWA C151/A21.51-02 or the latest revisions thereof.

All pipe joints shall be the push-on type, unless otherwise specified, employing a single, elongated grooved rubber gasket to affect the joint seal. All joints shall conform to the applicable requirements of ANSI/AWWA C111/A21.11-07 or the latest revision thereof. Where push-on locking or mechanical joint locking gaskets are specified, they shall be 'Field Lok' (red in color) by U.S. Pipe, "Sure Stop 350" by McWane or 'Fast-Grip' by American Pipe.

If flanged pipe is used, it shall be flanged ductile iron pipe with threaded flanges in accordance with ANSI/AWWA C115/A21.15-05 or the latest revision thereof. Flanged pipe shall have a minimum thickness of special Class 53 and be furnished with ductile iron flanges.

All pipes shall be double cement mortar-lined and double seal coated in accordance with ANSI/AWWA C104/A21.4-03.

#### Approved Manufacturers of Ductile Iron Pipe

McWane Ductile  
American Cast Iron Pipe Company  
United States Pipe & Foundry Company

#### Approved Manufacturers for Restrained Joint Ductile Iron Pipe Class

United States Pipe & Foundry Company (TR Flex)  
McWane Ductile (Super-Lock)

### PRE-INSULATED PIPE

#### **Service Pipe:**

**The service pipe shall be Ductile** Iron manufactured in accordance with ANSI/AWWA C151/A21-51. Push-on joints and mechanical joints shall be in accordance with ANSI/AWWA C111/A21.11

#### **Insulation:**

The insulation shall be a foamed in place closed cell polyurethane which completely fills the annular space between the carrier pipe and the exterior casing. The insulation shall have the following physical properties:

Minimum Density (lb./cu. ft.) 2.0 ASTM D-1621  
“K” Factor BTU/Hr. sq. ft. °F/in. .147 ASTM C-177  
90-95 % Closed Cell ASTM D-2856

**Exterior Casing: \***

The exterior casing shall be

(1) Seamless, extruded white PVC Type 1, Grade 1, Class 12454-B per ASTM D-1784 **or**  
(2) Seamless, High Density Polyethylene (H.D.P.E.) ASTM D-1248 with the following physical properties:

ASTM D-638.....Ultimate Elongation 850%  
ASTM D-638.....Tensile Yield Strength 3300 psi  
ASTM D-3350.....Resin Type III, Grade P34  
ASTM D-790.....Tangent Flexural Modules 175,000 psi

**No tape casings will be allowed.**

**Fittings:**

All fittings shall be mechanical joint and restrained with a mechanical retainer gland or a concrete poured thrust block.

Fittings shall be in accordance with AWWA C110 and AWWA C111.

**Approved Manufacturers:**

Tricon Piping Systems, Inc.  
Urecon Pre-insulated Pipe

**HDPE**

Pipe and fittings shall be made from the same resin meeting the requirements of the Plastic Pipe Institute (PPI) material designation PE 3408 with an ATSM D3350 minimum cell classification of PE 345464C. The material shall have a minimum Hydrostatic Design Basis (HDB) of 1,600 psi at 73 degrees F.

All materials which come in contact with water, including lubricants, shall be evaluated, tested, and certified for conformance with ANSI/NSF Standard 61. All pipe and fittings shall be manufactured in ductile iron pipe sizes (DIPS) only in accordance with AWWA Standard C906.

The pipe shall contain no recycled compound except for rework material generated in the manufacturer’s own plant that has the same cell classification as the material to which it is being added. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity. Permanent identification of water piping service shall be provided by co-extruding longitudinal blue stripes into the pipe outside surface. The striping material shall be the same material as the pipe material except for color. Stripes printed or painted on the outside surface shall not be acceptable.

The minimum pressure rating will be 200 psi.

Plain end butt fused fittings and electro-fusion couplings shall be used when joining polyethylene materials. Mechanical joint fusion adaptors shall be used when joining polyethylene materials to different piping materials for 4 inch and greater diameter. Mechanical (compression) fittings shall be used only when joining polyethylene materials to different piping materials for less than 4 inch diameter and approved by MWC.

**MAIN LINE FITTINGS**

Fittings shall be ductile-iron, double cement mortar-lined, double bituminous seal coated inside with mechanical or flanged joints, as specified, manufactured in the United States or Canada and in accordance with C153/A21.53-06 (Ductile iron Compact fittings) or the latest revision thereof. This standard includes tees, bends, offsets, sleeves, crosses, reducers, caps, plugs and connecting pieces. Gray iron fittings (ANSI/AWWA C110/A21.10.03) will only be used where specified.

Exterior coating for mechanical joint fittings shall be bituminous seal coat OR. Exterior coating for flanged fittings shall be bituminous seal coat or primer coated as specified.

All fittings shall meet the following required working pressure rating:

<u>ANSI/AWWA Standard</u>	<u>Pipe Material</u>	<u>Pipe Diameter (inches)</u>	<u>Type of Joint</u>	<u>Working Pressure Rating (psig)</u>
C153/A21.53-06	Ductile-Iron	3-64	Mechanical	350
C110/A21.10-03	Ductile-Iron	3-48	Mechanical	250
C115/A21.15-05	Ductile-Iron	3-48	Flanged	250

Approved Manufacturers

Tyler Union

**RETAINER GLANDS FOR MECHANICAL JOINTS**

CWC – Shall only use Megalug Series 1100, manufactured by EBAA Iron Inc.,  
 MWC Only – Romac Grip Ring for DIP sizes 4 – 12 inch, greater than 12 inch, Megalug noted above shall be used-

**BOLT THROUGH MJ ADAPTER FOR JOINT RESTRAINT**

In-Fact Corporation Foster Adapter 6-12 inches for the direct connection of MJ fittings.  
 In-Fact Compact Restrained Joint fittings (As specified by application)

**MAIN LINE RESILIENT-SEATED GATE VALVES**

(Up to and including 12")

Resilient-seated gate valves shall be full weight Ductile iron body, non-rising stem, mechanical or flanged joint\* complete with stainless steel trim, as specified, O-ring seal with a 2" x 2" operating nut, manufactured in the United States or Canada and in accordance with ANSI/AWWA C509-01 or the latest revision thereof. *Note: Lightweight/thin wall ductile iron body valves are **not** accepted.*

As a minimum, the inside of the valve body and bonnet are to be coated with a fusion bonded epoxy in accordance with ANSI/AWWA C550-05 or the latest revision thereof. All bolts shall be stainless steel ASTM F593.

\* Refer to ANSI/AWWA C111/A21.11-007 or the latest revision thereof.

Valves shall meet the following required working pressure rating:

<u>Pipe Diameter (inches)</u>	<u>Working pressure rating (psig)</u>
Up to 12	200

Gate valves opening direction should be ordered specific to each MWC or CWC Region System. Opening directions may be found in the Appendix.

**Approved Manufacturers and Products**

Mueller Company A-2362-20 (MJ); A2362-6 (Flanged)  
U.S. Pipe Resilient Seat Valve A USP223

**MAIN LINE BUTTERFLY VALVES**

(16" and larger)

Butterfly valves shall be Class 150B iron-body, bronze-mounted, mechanical ~~or flanged joint\*~~, as specified, rubber seated with a 2" x 2" operating nut, manufactured in the United States or Canada and in accordance with ANSI/AWWA C504-06 or the latest revision thereof. Valve seats shall be designed to provide tight shutoff at a pressure of 150 psig.

All flanged joint butterfly valves are to have hand wheel and position indicators.

If specified, all interior ferrous metal surfaces of each valve except finished or bearing surfaces shop painted with epoxy paint shall be in accordance with ANSI/AWWA C-550-05 or latest revision thereof. All Bolts shall be stainless steel ASTM F593.

\* Refer to ANSI/AWWA C111/A21.11-07 or the latest revision thereof.

Valve operators shall be furnished complete with the valves and ordered specific to each Region as indicated in the Appendix.

Approved Manufacturers

Henry Pratt Co., “Groundhog”  
Mueller Co., “Linesal III”  
VAL-Matic American - BFV  
M&H Valve Co.

**STAINLESS STEEL TAPPING SLEEVES**

All Tapping Sleeves shall be stainless steel unless ductile iron is called for on specific installations. Ductile specifications may be found in the Appendix. Only TPS brand stainless tapping sleeves may be used on Ductile Iron, Cast Iron and Transite water mains for size on size taps. Outlet flange to be Stainless. All nuts, bolts, etc. should be stainless steel and conform to AWWA Standard for Fabricated Steel and Stainless Steel Tapping Sleeves C223-02. Additional installation requirements may be project specific.

**Approved Manufacturers:**

Standard MJ Valve Sleeves

Total Piping Solutions – TPS Standard and Flanged Tapping Sleeves  
Power Seal #3490MJ  
Mueller H-304MJ

*\*Ductile Iron Tapping Sleeves may be required for certain installations. See Appendix for Specifications*

**VALVE BOXES**

Valve boxes shall be iron-body with close fitting dirt-tight covers, 2-piece (26 inch top, 36 inch bottom,) 5 ¼-inch shaft adjustable slide type. The top of the cover shall be flush with the top of the box rim with the word “WATER” clearly marked.

All Boxes for CWC & MWC lengths shall be sized as indicated above with the exception of:

Greenville and Millinocket Maine Typically 36” tops, 48” bottoms

Approved Manufacturers

Bingham & Taylor #4908  
Bibby St. Croix #V683 (5664)  
Tyler/Union Foundry #7126

**FIRE HYDRANTS**

Fire hydrants shall be Mueller Super Centurion 250 A423 with a standard shoe \*, dry-barrel, iron-body with one 4 ½-inch pumper\*\* and two 2 ½-inch hose connections with National Standard Thread manufactured in the United States or Canada and in accordance with ANSI/AWWA C502-05 or the latest revision thereof. All CWC hydrants shall be of the automatic drain type to prevent freezing.

All MWC hydrants shall NOT be of the automatic drain type; DRAINS MUST BE PLUGGED. All hydrants must have a minimum working pressure of 150 psig. Fire hydrants shall be ordered for the correct depth of bury for the application. Once in service, reflective hydrant collars will be installed under the supervision of CWC personnel, or authorized representative.

The hydrant main valve shall be designed to remain closed in the event of a break in the hydrant above or near grade level. The hydrant base inlet shall be 6 inches in diameter with mechanical joint ends for connection to a 6-inch M.J. gate valve and mechanical joint anchoring tee.

All fire hydrants shall be factory coated only, provided with a stenciled CWC identification label and be provided with a letter of verification from Mueller as to the origin, coating and distributor account for warranty verification. The Distributors Account Number is required to be stenciled on the barrel for identification.

\* The D-150 should be requested when installing hydrant directly to an oversized branch valve.

\*\*If CWC/MWC determines the hydrant is for use on a 6-inch main with available flow 500 gpm or less, use a Mueller Super Centurion 250 A422 (only two – 2 ½” hose connections).

Hydrant information specific to each CWC or MWC System may be found in the Appendix.

### **POLYETHYLENE ENCASEMENT**

Polyethylene sheeting and tubing used for the external corrosion protection of buried ductile-iron pipe, fittings and appurtenances shall meet American Water Works Association ANSI-AWWA C105/A21.5-99(10) standards. The material shall be produced from a low density polyethylene with a density of 0.910 to 0.935 and a minimum thickness of .008 inches (8MIL) or if designated by the Company a high density cross laminated polyethylene with a high density of 0.940 to 0.960 and a minimum thickness of .004 inches or (4Mils) and shall be Black in color.

Unless otherwise specified or approved, all material supplied shall be either as a continuous rolls, perforated at either 20 or 22 foot intervals. It shall be marked with the following information:

- A.) Name of manufacturer
- B.) ANSI/AWWA C015-A21.5
- C.) 8 MIL LLDPE or 4 MIL CLHDPE
- D.) Applicable range of nominal pipe diameter
- E.) Warning – Corrosion Protection – Repair Any Damage

**Each shipment shall contain certification that the material meets the minimum requirements specified by American Water Works Association Specification ANSI-AWWA C105/A21.5-99.**

Temflex™ 1100 vinyl corrosion protection tape by 3M shall be used to secure all polyethylene sheeting and tubing.

### **AIR VENTS - BLOWOFFS (If Specified – See Standard Details [SD5](#) and [SD5A](#))**

Kupferle – TF500, all brass blow-off hydrant

Blowoff valves shall be a 2inch gate valve. Open direction shall be same as Region valves as specified in the appendix.  
SDP top mount air vent, 1inch only

### **WARNING TAPE**

Warning tape shall be a minimum 3-inch wide, 4.0 mil polyethylene film suitable for buried service. The tape shall be blue in color per the A.P.W.A. National Color Code and shall be permanently imprinted with a warning label indicating a “Water Main Buried Below.”

### **SUBSURFACE INSULATION – Specified on a job by job basis.**

### **CHLORINE TABLETS**

5 gram calcium hypochlorite tablets, **non-stabilized**, installed per the Disinfection Section of the project specifications, and in accordance with AWWA C651-05.

### **LIQUID CHLORINE INJECTION (See Standard Details SD-27 & SD-28)**

### **REPAIR CLAMPS – MISCELLANEOUS FITTINGS**

All repair clamps and miscellaneous fittings should be stainless steel, epoxy, or nylon coated and use all stainless steel nuts, bolts, etc. and full face rubber gaskets where available.

#### Approved Manufacturers

Ford  
Smith Blair  
Romac  
Mueller  
Dresser

#### Wide range transition couplings approved for use up to and including 12”

Mueller: Maxi-Range  
TPS – Quick Cam  
Hymax for non-uniform size only  
Romac – MACRO – Trial basis  
**Hymax Grip Coupling** (for restraint of non-uniform size only)

#### Wide range transition couplings approved for use over 12”

Smith Blair # 44  
Romac # 501



## **SERVICE LINES AND ACCESSORIES**

### **SERVICE LINES**

Service lines shall be type “K”, soft seamless copper tubing with no soldered joints underground. Copper tubing to be manufactured in the United States or Canada and ordered in 60-foot (100-foot for special projects) single flat coils for 3/4”, 1” and 1 ½” sizes or 40-foot single flat coils for 2” size (standard minimum service size is 1”).

Service line connections from corporation main valve to curb valve **shall only be type K copper** unless otherwise approved by CWC/MWC.

As specified by the Company the use of plastic pipe on the customer side of curb valve may be approved by the Company; such pipe shall be PE 4710 polyethylene, rated for 200 psi working pressure, meeting AWWA C901-02, with this information and the NSF seal appearing on the pipe. Stainless Steel inserts to be provided at compression connections.

Service lines larger than 2 inch in size shall be ductile iron pipe in accordance with the material specifications for water mains.

Nonmetallic pipe must be paralleled by a metallic wire for ease of locating. Said wire shall be 12AWG stranded copper with an HMW-PE jacket.

### **STRAP SERVICE SADDLES** (for 1 inch and above taps)

Double strap service saddles shall have epoxy or nylon coated body and stainless steel nuts, bolts and double straps. Taps shall be CC (Mueller) Thread unless otherwise noted.

#### Approved Manufacturers

Smith-Blair #313 or #317 or #239

Romac #202N

Ford FCD 202

Mueller #DE2S

U.S. Pipe #DR2S

### **CORPORATION STOPS (valves)**

Corporation stops shall be Mueller ball type corporations B25008N1 rated for 300 psi bronze-body ground key design manufactured in the United States or Canada in accordance with ANSI/AWWA Standard C800-05. The inlet shall have a standard AWWA corporation valve inlet thread (Mueller - CC) and the outlet shall be a compression connection for copper tubing.

### **CURB STOPS (valves)**

Curb stop valves shall be bronze-body and manufactured in the United States or Canada in accordance with ANSI/AWWA Standard C800-5. Both ends of curb stop valves shall be compression connections for copper service tubing. MWC Standard shall be Ball Valve style rated for 300 psi. CWC shall be Mueller Mark II Oriseal H-15209.



Approved Manufacturers

Mueller Mark II Oriseal H-15209, Mueller 300 Ball Valve B-25209  
Ford B44-444-Q  
A.Y. McDonald – 6100-Q

If a curb stop valve is needed with a drain (stop and waste), it shall be a Mueller Mark II Oriseal H-15219 or other approved manufacturer.

**CURB BOXES**

Curb boxes shall be iron-body with close fitting, dirt tight or screw type covers. The top of the cover shall be flush with the top of the box rim with the word ‘WATER’ clearly marked.

Curb boxes for MWC shall be Erie Style with Stainless Steel Rods with lengths specific to each installation. Curb boxes for CWC are ordered specific to each Region and may be found in the Appendix. Any Erie style boxes for CWC shall also be equipped with Stainless Steel Rods.

**METER PITS**

Meter Pits shall be .486 inch minimum wall PVC or polyethylene, eighteen inch in diameter per CWC drawing SMS-3, dated 10/31/07 for 5/8 x 3/4” and 3/4” meters. Twenty-two inch diameter meter pits per drawing, SMS-3A dated 10/31/07, shall be used for 1” meters. Meter pits are to be furnished with cast iron frame and 15” or 18” diameter lid to say “Water.” Covers to be drilled for touch pad reader and supplied with plug. Frames and covers also to include full diameter foam insulation pad with cutout for meter access.

Approved Manufacturers:

Mueller/McCulloch  
QWP  
A.Y. McDonald

**METER YOKES (HORNS) – Required for CWC only**

Meter Yokes shall be corner style with locking corner brass valves for sizes 5/8” x 3/4”, 3/4” or 1” per CWC drawing SMS-1, dated 4/6/04 or SMS-2, dated 4/13/04 with pressure-reducing valve for size 5/8” x 3/4”. With exception of Avon Water, the Meter Yoke shall be a Ford No. 2 copper horn.

Approved Manufacturers:

Mueller Company  
Ford Meter Box Co.  
A.Y. McDonald

**TRIAL ITEMS**

Products selected for trial basis are at the discretion of CWC. Those selected and placed in use, must be in use for at least six months prior to approval. Upon the conclusion of said period, final approval of the product will be at the discretion of CWC.

Products currently on trial:

1. TPS Quick-Sleeve Wide Range Bell Joint Repair Coupling
2. Kennedy Resilient Wedge Gate Valve
3. Romac Macro Coupling

## Appendix

### CWC & MWC Gate and Butterfly Valve Opening Directions

<u>CWC Systems</u>	<u>MWC Systems</u>	<u>MWC Contracts</u>
Shoreline - Open Right	Biddeford Saco - Open Right	South Freeport - Open Right
Naguatuck - Open Right	Camden Rockland - Open Right	Waldoboro - Open Right
Terryville - Open Left	Union & Warren - Open Right	Vinalhaven - Open Left
Thomaston - Open Left	Skowhegan - Open Right	
Unionville - Open Left		
Avon – Open Left	Oakland – Open Left	
Collinsville - Open Left	Hartland - Open Right	
Northern - Open Left	Bucksport - Open Left	
Rockville - Open Right	Millinocket - Open Left	
Vernon - Open Right	Greenville - Open Left	
Ellington-Open Right		
Crystal Systems - Open Left	Freeport - Open Right	
Gallup System - Open Right	Kezar Falls - Open Left	
Mansfield - Open Left		
*Heritage Village – Open Right		

\*Heritage Village ‘*In the Village*’ is Open Left

MWC Hydrant Information

<u>MWC System</u>	Color	Bury	<u>MWC Contracts</u>	Color	
Biddeford Saco - Open Right	Yellow	5'6"- 6'0"	South Freeport - Open Right	Yellow	6'0"
Camden Rockland - Open Right	Red	5'6"- 6'0"	Waldoboro - Open Right	Red	5'6"- 6'0"
Union & Warren - Open Right	Red	5'6"- 6'0"	Vinalhaven - Open Left	Red	6'0"
Skowhegan - Open Right	Red	6'0"			
Oakland - Open Left	Red	6'0"			
Hartland - Open Right	Red	6'0"			
Bucksport - Open Left	Yellow	6'0" + 7'0"			
Millinocket - Open Left	Orange	6'0"			
Greenville - Open Left	Orange	6'0"			
Freeport - Open Right	Yellow	6'0"			
Kezar Falls - Open Left	Yellow	5'6"			

CWC Hydrant Specifications

<u>CWC System</u>	<u>Direction</u>	<u>Seat</u>	<u>Paint Scheme</u>
Shoreline	Open Right	5 ¼	Yellow Barrel/ White Bonnet
Naugatuck	Open Left	5 ¼	Red Body/White Caps & Bonnet
<sup>1</sup> Northern	Open Left	5 ¼	Yellow Barrel with White Bonnet
Crystal	Open Left	5 ¼	Red
<sup>2</sup> Gallup	Open Right/Open Left	5 ¼	Red
Unionville	Open Left	5 ¼	Red
Avon	Open Left	5 ¼	Red Body/ Green Caps & Bonnet
Mansfield	Open Left	5 ¼	Red
<sup>3</sup> Heritage Village	Open Left	5 ¼	Red

<sup>1</sup>Confirm geographic location to conform to Town of Enfield fire districts' color schemes prior to purchase

<sup>2</sup>Confirm geographic location with region for open direction prior purchase

<sup>3</sup>Town of Southbury hydrant paint scheme: Red/White Caps

CWC Curb Box Specifications

<u>Region</u>	<u>Service Size</u>	<u>Type</u>	<u>Manufacturer &amp; Model</u>
Shoreline	1" & 1 ½"	Extension type With 27" long stationary rod (Mueller # 82863) (SS rod for use in salt water areas)	Mueller H-10314 QWP "Laroache" Bibby #R1500
Shoreline	2"	Extension type With 30" stationary rod (Mueller # 580562)	Mueller H-10386

Naugatuck Northern Crystal Gallup Heritage Village	1” through 2”	Slide type 2 ½-inch shaft	Bingham & Taylor 95E Slip Bibby St. Croix #V213
Unionville	1”  1 ½” – 2”	Extension type With 33” long stationary rod (Mueller # 82864) Extension type With 33” long stationary rod (Mueller # 82864) <i>and</i> Installed over enlarged base	Mueller H-10314 QWP “Laroache” Bibby #R1500  Mueller H-10314 QWP “Laroache” Bibby #R1500 Bibby #V313
Mansfield	1” through 2”	Extension type With 27” long stationary rod Or Slide type 2 1/2 inch shaft	Mueller H-10314 QWP “Laroache” Bibby #R1500 Bingham & Taylor 95E Slip Bibby St. Croix #V213
Avon	1” through 2”	Erie #1 Curb Box & Rod with 30” stationary rod.	

**Note: Enlarged base section may need to be used on service lines with 2in ball valves and larger**

**DUCTILE IRON TAPPING SLEEVES**

Tapping sleeves are to be manufactured from ductile iron. Tapping sleeves are to only be used in conjunction with a mating tapping valve from same manufacturer. All sleeves are to include the end joint accessories and split glands necessary to assemble sleeve to pipe. MJ bolts and nuts are to conform to ANSI/AWWA C111/A21.11-07. Inside and outside of all tapping sleeves to be coated in accordance with AWWA Standard for Ductile Iron Compact Fittings ANSI/AWWA C153/A21.53-06 Section 4.3.

Approved Manufacturers

Mueller Company – H-615 (for use on C.I. & D.I. pipe), H-616 (for use on Pit Cast C.I. pipe)

**MISCELLANEOUS**



President's Message

Dear Colleagues,

It is my privilege to be part of this team of professionals at Connecticut Water!

I am extremely proud of the high quality of service that you provide to your customers every day. No matter what your role or responsibility, you play an important part in determining the success of our mission...

What we do here is extremely important. It makes a real difference in the lives of people and communities. And yet how we perform that task is also vitally important. As President, I willingly accept the responsibility of creating and maintaining a safe working environment for you...

The Connecticut Water Safety Manual has been developed by a team of employees here at the company, coupled with industry best practices. Our extensive track record of safety speaks for itself...

Please join me in this endeavor.



Eric W. Thernberg, President



SAFETY MANUAL



JULY 2011

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Table with 3 columns: SECTION, PAGE, and content. Includes sections like General Rules, Medical Emergencies, Office, Garage/Storage Area Housekeeping, Company Vehicles/Equipment, Fueling Vehicles, Personal Protective Equipment (PPE), Forklift Operations, Lifting, Hand Tools, Pneumatic Tools, Ladders, Scaffold, Barriers and Warning Signs, Handling Pipe, Excavations, Trenches, and Pits, Confined Space Entry Procedures, Respiratory Protection, Electrical Safety, Lockout/Tagout Procedures, Hot Work Policy, Material Safety Data Sheets (MSDS), Meter Reading/Changing, Milling Operations, Fall Prevention and Protection, and Discipline.

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CONNECTICUT WATER

Safety Program

Throughout this manual, "Connecticut Water" and/or the "Company" means the Connecticut Water Company, New England Water Utility Services, and any company companies hereinafter acquired, collectively.

Contractors performing work for Connecticut Water must also follow the rules in this manual and comply with all state and federal safety regulations.

Since it is impractical to provide rules to meet all conditions, employees are expected to follow the advice of their supervisors for any work situation or emergency not addressed in these rules. If no instructions are given, nor any supervisor available, it shall be the duty of the employee to do that which will prevent personal injury and/or damage.

It is expected that the employee will promptly report and seek remedy for any unsafe equipment or condition. If any employee feels their supervisor does not adequately address a safety concern, they should bring the matter to the attention of a senior manager in their department, their Vice President, and/or Human Resources. At no time shall there be retaliation against any individual bringing forth safety concerns.

Employees shall immediately report any accidents or injuries to their supervisor and Human Resources. The Company will promptly investigate any such accidents or injuries.

Any employee who willfully violates any of the safety rules set forth on the following pages, or who unnecessarily endangers their own or others' personal safety, shall be subject to disciplinary action.

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OFFICE

- 3.00 Good housekeeping is a keynote to safety. Keep your desk and office area clean and orderly.
3.01 Drawers to desks, tables, and filing cabinets are tripping hazards. Keep them closed when not in use and watch your fingers when closing them.
3.02 Never open more than one file drawer at a time.
3.03 Do not use makeshift devices to reach high shelves. Always use a step stool or ladder. Store heavy objects on lower shelves.
3.04 Keep aisles and passageways clear of materials. Store materials inside cabinets, files, and/or lockers whenever possible.
3.05 Never carry anything that obscures your vision.
3.06 Adjust CRT monitors and workstation equipment for minimum neck, back, and eye strain. Follow simple ergonomic guidelines.
3.07 Do not place electrical cords or phone cords in areas where they will create tripping hazards. Use only approved extension cords or terminal strips.
3.08 Turn off any electrical appliances before unplugging them.
3.09 Do not use space heaters or coffee pots at individual workstations or offices except as authorized.
3.10 Never use the elevator when alone in the building or during a fire.
3.11 Know the building evacuation plan and follow it during fires and drills.
3.12 Know the fire alarm sounds and respond to it when it sounds. Company policy is for all employees to evacuate the building in the event of a fire.
3.13 Use power strips to power down computer/printer/monitor after logging out to save energy.

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GARAGE/STORAGE AREA HOUSEKEEPING

- 4.00 Keep their floor free of grease and oil spots, driplights, air hoses, tools, etc., to prevent injury due to slipping and tripping.
4.01 Be sure that all tools and equipment are free of oil and grease to prevent injury when using them. Keep drop cords and other wires free of oil and grease to prevent the wires from deteriorating and becoming a hazard.
4.02 Dispose of gasoline and/or soaked rags and papers in approved types of safety containers.
4.03 Do not keep gasoline or other flammable liquids in open containers. Store in approved safety containers and in cabinets.
4.04 Observe and obey "No Smoking" signs posted. Do not smoke in battery charging areas. No smoking is permitted in any CWC facility or in Company owned vehicles.
4.05 Do not pour chemicals, gasoline, kerosene, oil, or other flammable liquids down sinks or floor drains.
4.06 Do not use gasoline for cleaning.
4.07 When operating a forklift, be sure all clothing and hands are free of the lift and that the immediate area is clear of personnel and equipment before raising or lowering the lift.
4.08 Avoid overloading hand trucks. Balance the load carefully to avoid strain on the operator. Follow all forklift handling procedures (see Section 8).
4.09 Keep all aisles and walkways clear. Passageways should be of sufficient width to permit the transportation of materials to and from storage.
4.10 To minimize fire hazards, do not permit wastepaper, scrap lumber, or other material to accumulate on the premises.
4.11 Avoid over-filling storage bins causing the material to protrude into the aisles.

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COMPANY VEHICLES/EQUIPMENT

- 4.12 Do not store round objects at an elevation unless they are completely contained in a bin or box. (i.e. Pipes)
4.13 Be certain that materials are stacked properly; always pile them on a firm, even foundation. Do not permit the stacks to reach a hazardous height. When possible, cross tie the tiers for mutual support.
4.14 When storing heavy materials in buildings, stay within the safe load limits of the floors where stored, as well as limits of any equipment (unless designed to hold weight) used to handle these materials. Do not place any heavy materials on grades.
4.15 Wear gloves when handling wooden crates, metal containers, pipe fittings, or any other object with rough surfaces that could cause injury to your hands.
4.16 When uncrating materials, remove all projecting nails or metal straps, or bend them out of the way before actually starting the job of unpacking.
4.17 When storing materials, leave a minimum of 18-inches between the top of the pile and any sprinkling system heads.

SAFETY MANUAL

General Rules

- 1.00 Follow the instructions of your assigned supervisor. If you do not understand the work assigned to you, ask for further instructions.
1.01 Employees should monitor for safe equipment and work conditions and report any unsafe equipment or condition to their supervisor, and/or the Human Resources Department.
1.02 Immediately report any injury and/or accident, no matter how small, to your supervisor and the supervisor will report the accident to the Human Resources Department.
1.03 Exercise caution and heed all warnings, signs, and signals which may prevent you from being injured. Observe all posted safety signs.
1.04 Be aware of your surroundings when entering a customers' property so as not to subject yourself to any hazardous situation.
1.05 No employee shall operate any type of machine or equipment which they are not trained or authorized to use.
1.06 Safety and personal protective equipment are issued for your protection. Make use of this equipment as outlined in the Company's Safety Manual and as further required by the job being performed.
1.07 Tools, personal protective equipment, and other equipment shall be kept in good serviceable condition. Employees are responsible for the maintenance of their tools and personal protective equipment and should advise their supervisor if equipment needs repair or replacement. Equipment that is broken or needs to be repaired shall be tagged "out of service" and removed from the vehicle at the end of the day for repair and/or replacement.
1.08 Follow all rules and practices for safe material handling.
1.09 Do not make repairs, adjustments, or changes in fixtures or equipment without the proper authority or instructions.
1.10 When using stairs, take one step at a time, use the handrail whenever possible, and walk, do not run.

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- 1.21 Doors shall be kept open or closed all the way in order to prevent accidental contact or collision hazards.
1.22 Smoking is permitted in designated areas only. Matches, cigars, cigarettes, and pipe tobacco shall be disposed of in suitable containers. They shall not be thrown in wastebaskets, on the floor, or out of windows.
1.23 Do not engage in "horseplay"; it is dangerous and often leads to accidents.

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EMERGENCY ACTION PLAN

MEDICAL EMERGENCIES

- 2.00 Employees should always call 911 for professional assistance if an employee is injured or has a medical emergency while on the job. Employees should not drive other employees to the hospital. They should be transported by way of ambulance. All injuries should be immediately reported to the employees' supervisor and to Human Resources.
2.01 Employees are not to administer any medical treatment beyond basic first aid. If an employee chooses to administer minor first aid, the employee must have been properly trained and use the proper personal protective precautions. Any such actions will be under the Good Samaritan Principle.
2.02 The Company may periodically provide its employees with Multimedia First Aid training; participation is voluntary. This training was developed to provide fundamental principles and skills in First Aid. It prepares employees to care for most minor injuries.
2.03 Know the fire alarm sound and respond to it when it sounds. Company policy is to evacuate the building in the event of a fire alarm.

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- 5.12 The use of a 2-way radio while driving is to be avoided. If you need to use the radio, stop at a safe location before using. If called on the radio while driving, respond with "please stand by" to let the caller know you heard them and then pull off to a safe location before continuing the conversation.
5.13 Ignition keys are to be removed when leaving vehicles unattended as well as lock the vehicle doors if out of sight.
5.14 Secure and/or cover all loads on or in vehicles to prevent them from shifting or blowing out in transit.
5.15 All projections either in front or rear of vehicles shall be properly flagged.
5.16 Do not ride on any part of a car, truck, or other equipment that is not meant for passenger use. Do not get on or off a vehicle or equipment while it is in motion.
5.17 Before towing any equipment, inspect hitch, check lights, chains, and tow bars for proper hook-up and condition.
5.18 Amber rotating lights or emergency flashers on Company vehicles shall be used as a public service warning device when the Company vehicle is parked during times of poor visibility, and at any time between sunset and sunrise, with any part of the vehicle on or closely adjacent to any roadway.
5.19 Any Company vehicle parked on or near a public highway shall be parked in the same direction as that of the flowing traffic, or within a secured work zone.
5.20 When Company vehicles are used to carry chemicals, Department of Transportation (DOT) placards must be utilized and Daily Inspection Reports must be completed, as required.
5.21 Body safety hoist hooks must be used whenever fluid checks of dump trucks are done.

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(A) DRIVERS' REPORT OF QUARTERLY VISUAL VEHICLE INSPECTION

NOTE: CLASS I & B VEHICLES, INSPECT DAILY
Form with fields for Date, Vehicle No., Make of Vehicle, Driver's Name, and a table for EQUIPMENT inspection (Air Compressor, Brakes, Lights, etc.) with columns for OKAY and NEEDS ATTENTION.

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(B) Driver's Daily Vehicle Inspection Report

Form with fields for Date, Time, and P.M., and a table for TRACTOR NO. and TRAILER NO. inspection (Air Compressor, Brakes, Lights, etc.) with columns for OKAY and NEEDS ATTENTION. Includes a section for REMARKS.

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FUELING VEHICLES

- 6.00 Do not leave engine running while fueling a vehicle.
- 6.01 Drain hose before removing nozzle from fuel tank.
- 6.02 Hang nozzle securely on gasoline pump, replace hose to a safe position, and make sure cap on vehicle's tank is secure and tight.
- 6.03 Avoid fueling vehicles during an electrical storm.
- 6.04 Operator shall remain at the discharge nozzle during fueling. Fuel spills shall be reported immediately to supervisor and established spill response procedures are to be followed.
- 6.05 Do not smoke or use cellular phones during a fueling operation or pump near open flames or sparks.
- 6.06 Portable gasoline containers must be DOT approved and appropriately identified. Before filling portable fuel containers, make sure there is contact between the container and the gasoline nozzle to prevent sparking from static electricity. Containers shall be placed on the ground prior to and while being filled.
- 6.07 When fueling portable machinery, never run hose across the engine, and always make sure there is contact between the tank and the gasoline nozzle. Do not fuel portable machinery when hot or running.
- 6.08 Portable gasoline containers shall be properly secured during transportation.

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PERSONAL PROTECTIVE EQUIPMENT (PPE)

- 7.00 Not every condition warranting the use of safety equipment can be predicted. Therefore, in addition to the situations indicated below, Personal Protective Equipment (PPE) shall be utilized at all times when conditions warrant and all personnel exposed to dangerous conditions shall abide by the pertinent regulations.
- 7.01 Employees shall not exercise common sense and judgment regarding appropriate PPE. PPE shall be made available to employees for all required operations. If proper PPE is not available, employees should advise supervisor and not perform the work that would require the PPE.
- 7.02 Safety glasses or safety goggles as appropriate, along with a full-face shield must be worn:
  1. While pouring or handling hot liquid.
  2. While blowing out carb boxes and gate boxes.
  3. While using grinding wheels, buffing machines, brushing and chipping, or bush cutting.
  4. While working with Sodium Hypochlorite, Lime, Hydrofluosulfonic Acid, Caustic Soda, or any other chemical which could cause eye injuries. See specific rules regarding these chemicals.
  5. While using a pick, jackhammer, pneumatic drill, paving breaker, etc.
  6. While pipe cutting, welding, cutting, and burning.
 Each Connecticut Water employee who has occasion to work under any of the above conditions will be furnished with, and shall be responsible for, his/her own pair of goggles. Safety glasses without side shields are not a substitute for safety goggles or a full-face shield.
- 7.03 As required, appropriate footwear will be worn at all times during working hours. All field employees will wear long pants unless authorized by your supervisor of Human Resources.

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FORKLIFT OPERATIONS

- 8.00 All employees are required to be trained prior to operating a forklift.
  - To comply with the Occupational Safety and Health Administration (OSHA) Standard 1910.178, all new and current Connecticut Water employees who are required to operate a forklift must first attend training consisting of a combination of formal instruction, practical training, and evaluation of the operator's performance in the workplace. Training will be specific to the powered industrial vehicle the employee will be operating, and will be conducted by a Certified Connecticut Water Forklift Instructor.
  - Topics Covered:
    - o Safe operation
    - o Operating instructions, warnings, and precautions
    - o Controls and instrumentation
    - o Steering and maneuvering
    - o Vehicle capacity and stability
    - o Engine or motor operation
    - o Visibility
    - o Inspection and maintenance
    - o Workplace hazards
    - o Load manipulation, stacking, and unstacking
    - o Ramps and sloped surfaces
    - o Refueling and/or charging and recharging of batteries
    - o Pedestrian traffic
    - o Fork and attachment adjustment, operation, and limitations
- Upon successful completion of the written and practical examinations, the employee will receive a Forklift Safety Training Certificate. **NOTE:** An evaluator of each powered industrial truck operator's performance shall be conducted at least once every three years.

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FORKLIFT OPERATIONS

- 8.00 All employees are required to be trained prior to operating a forklift.

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PNEUMATIC TOOLS

- 11.00 Always use the proper tool and appropriate PPE required for the job. Be sure the tool you are using is in good working condition.
- 11.01 Do not use any circumstances point a portable pneumatic tool at anyone.
- 11.02 Do not use compressed air to dust off your clothing or any part of your body.
- 11.03 Check all hose couplings periodically for tightness.
- 11.04 Release the pressure on air hoses or lines before uncoupling or disconnecting them.
- 11.05 Do not kick an air hose to cut off an except in an emergency.
- 11.06 Guard pneumatic tools against accidental operation.
- 11.07 Follow appropriate noise control measures when using pneumatic equipment (see Section 7).

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LADDERS

- 12.00 Each employee who is required to use a ladder shall follow the standards and requirements contained in OSHA regulations.
- 12.01 Ladder side rails shall extend at least three feet above the surface to which the ladder is being used to gain access (i.e., three feet above the top of the trench).
- 12.02 Ladders shall be maintained free of oil, grease, and other slipping hazards.
- 12.03 Ladders shall be labeled with rated capacity and shall not be loaded beyond capacity.
- 12.04 Ladders shall be used only for the purpose for which they were designed.
- 12.05 Non-self-supporting ladders (extension ladders) shall be used at an angle so that the foot of the ladder is 1/4 the distance of the vertical height (an angle of approximately 75 degrees).
- 12.06 Ladders shall be used only on stable and level surfaces unless secured to prevent accidental displacement.
- 12.07 The area around the top and bottom of ladders shall be kept clear.
- 12.08 Ladders shall not be moved, shifted, or extended while a person is standing on them.
- 12.09 The top or the top step of a stepladder shall not be used as a step.
- 12.10 The Competent Person (See Section 16) on the construction site must inspect the ladders (look for visible defects) on a periodic basis to make sure they are in good working order.
- 12.11 Ladders shall be inspected prior to each use. Any ladder missing its certification label, or identified with structural defects (i.e., broken or missing rungs, cleats or steps; broken or split rails; corroded parts, etc.) shall either be immediately marked in a way that identifies it as defective or be tagged with "DO NOT USE!" or similar wording, and taken out of service until properly repaired.

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SCAFFOLDING

- 13.00 Scaffolds and other elevated work platforms are responsible for many accidents through falls and falling objects. Only properly designed and constructed scaffolding and staging may be used.
- 13.01 Scaffolds should be designed, built, and inspected by Competent Persons (See Section 16). To avoid the use of makeshift platforms, each job should be carefully examined ahead of time so that all necessary ramps and platforms can be provided when needed.
- 13.02 Each scaffold should be designed for the loads which will be carried on in the performance of the work at hand. All loads, including workers, building materials, and the weight of the scaffold structure itself must be taken into account. The structure should be designed for a FACTOR OF SAFETY of at least 4.
- 13.03 Adequate footings, such as planks, should be provided for uprights, especially when they rest on earth, sand, or loose material. Cross bracing must be used to provide stability.
- 13.04 Permanent ladders or stairs should be provided. If a ladder is used, it should be secured firmly against slipping and overturning. Ladders may be of standard manufacture or built on the job.
- 13.05 Adequate hand protection must be provided for workers on the scaffold if work is being carried out overhead. A roof of lumber, heavy canvas, or screen wire should be used as appropriate.
- 13.06 Handrails and intermediate rails should be provided on all open sides of working platforms. Screening is recommended. Toeboards should be installed on all open sides of working platforms.

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Rougher Training

- 8.01 Rougher Training in relevant topics shall be provided to the operator when:
  - o The operator has been involved to operate the vehicle in a unsafe manner
  - o The operator has been observed in an accident or near-miss incident
  - o The operator has received an unsatisfactory evaluation
  - o The operator is assigned to drive a different truck
  - o The conditions in the workplace have changed, affecting the safe operation of the truck.
- 8.02 Employees shall not operate a forklift unless they attend initial and additional training, as required by Occupational Safety and Health Administration (OSHA) standard.

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HAND TOOLS

- 10.00 Misuse of tools, or tools that are not properly maintained, are responsible for the largest percentage of all industrial accidents. By adhering to the following proven safety presentations, a major part of these accidents can be avoided.
- 10.01 Always use the proper tool and appropriate PPE required for the job. Adjust tools to appropriate settings prior to use.
- 10.02 Check the condition of a tool before each use and repair or replace if it is defective. Tag and remove any broken or damaged tool. Report any defects to your supervisor.
- 10.03 Do not use tools on moving machinery. Follow Lockout/Tagout procedures (see Section 20).
- 10.04 Check the clearance to make sure there is sufficient space if the tool should slip.
- 10.05 Have a good support underfoot so that there is no hazard of slipping, tumbling, or falling.
- 10.06 To prevent slipping, make sure all tools are clean and free from oil or grease. After using tools, wipe them clean and put them away, thus keeping them in good condition and keeping the work area orderly.
- 10.07 Use proper equipment, or get assistance from others if lifting heavy objects.
- 10.08 Never hold tools in your hand when using a screwdriver, place it on a flat surface or use a vise.
- 10.09 Always use tools with insulated handles for electrical work.
- 10.10 Be sure all portable electric power tools are grounded before you use them. Only a ground fault interrupter is acceptable when using electric power tools for any situation. Electrical work should be done by trained personnel only. Employee is responsible for documenting and testing all equipment at every use.

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- 9.00 Sprains and strains to the muscles, tendons, and ligaments of the back are common injuries that are often avoidable. Be aware of the causes of back injuries and your lifting limitations. Remember, back injuries don't happen just at work; they can happen at home, or while you're out having fun. A back injury often limits all of your activities, so following proper lifting techniques can help keep you healthy.
- 9.01 Poor posture can put stress on back muscles. Poor physical condition can lead to weak back muscles. Practice a regular exercise program to stretch and strengthen your back muscles. Bending or twisting while lifting can cause injury. Repeated minor strains can develop into an injury. Back injuries are not always caused by lifting something too heavy, as it is not necessarily the weight of an object but how it is lifted that results in an injury. Stress and tension can contribute to back pain.
- 9.02 Size up the load. Test the weight by moving a corner of the object, and get help for heavy or awkward loads. Make sure that you have a clear path to carry the load, and a clear area to set it down.
- 9.03 Stand with your feet close to the object and center yourself over the load. Bend your knees to allow the work to be done by your legs, not by your back. This is the single most important part of lifting. The large muscles in your legs are designed to carry weight, and bending your knees gets your legs ready to support the load. Get a good grip on the object. Clean and dry surfaces are easier to handle than wet and greasy ones. Straighten your legs to lift straight up in a slow, smooth motion.
- 9.04 Keep the load held close to your body. Do not twist or turn while carrying the load. Sudden twisting motions can injure the disks in your back. Bend your knees again as you lower the load to set it down.
- 9.05 Loads on carts or wheels should be pushed, not pulled. Get help for lifting items that are long, bulky, that don't have a good place to grip or are too heavy for one person. Know when mechanical lifting equipment should be used instead of manual lifting. If possible, divide a heavy load into several smaller ones.

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- 10.11 Do not use the extension cord on electric tools as a means of raising or lowering the tool. Only use extension cords in temporary situations. Never use a broken or frayed.
- 10.12 Guard against accidental starting of electrical tools and disconnect them when making repairs.
- 10.13 Grinding wheels (portable and pedestal) shall be firmly mounted prior to use. All guards and tool rests should be inspected and adjusted prior to use.

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BARRICADES AND WARNING SIGNS

- 13.07 The following general rules are prescribed for maintaining all types of scaffolding in safe working condition:
  1. All scaffold structures should be inspected at least daily by the project manager, project engineer, or other responsible person designated by the job superintendent to perform this task.
  2. No structural modification of any kind should be made in scaffolds.
  3. The structure should be cleared of all rubbish daily. No tools should be left on scaffolds overnight.
  4. No excess materials should be stockpiled on scaffolding.
  5. Notices regarding the use of scaffolds, when needed, should be conspicuously displayed and observed.
  6. Scaffold structures should be protected from trucks and other vehicles which might come into contact with them.
  7. Working platforms should be free of ice, snow, oil, etc., before being used.
  8. No open fire should be permitted on or near scaffolds.

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HANDLING PIPE

- 15.00 The handling and storage of materials in the construction industry is one of the major causes of composable work injuries in the United States. By designing safety programs, training employees to use these procedures correctly, and having at least one experienced person available at all times, accidents can be prevented.
- 15.01 Detailed below are the correct procedures that must be adhered to by employees or contractors working on Company property when unloading ductile iron pipes and fittings:
  - The pipe is shipped from the manufacturer on flatbed trucks in standard 18 and 20 foot lengths. The following is a guide to the approximate weight of some standard 18 and 20 foot pieces of ductile iron pipe:
 

Pipe Diameter (inches)	Weight (lbs)	18 Ft. Length	20 Ft. Length
6	375	415	
8	530	585	
10	690	765	
12	870	960	
16	1270	1400	
20	1670	1840	
24	2100	2320	

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- 14.00 Place approved warning signs well ahead of construction or repair areas to warn traffic of hazard. Follow DOT permit required traffic signing as needed.
- 14.01 When trucks and air compressors are being used, keep them between the work area and traffic, if possible.
- 14.02 Protect the work area with barricades and traffic cones to provide a safe place for your work and the public.
- 14.03 Do not use traffic cones as barricades; they are to be used only for diverting traffic.
- 14.04 Flag persons trained in compliance with DOT regulations must be used when necessary. Such flag persons must be properly equipped to divert and slow down traffic. Employees who have not been properly trained must not be flag persons.
- 14.05 Proper warning lighting on equipment must be used for all operations in areas exposed to traffic flow.
- 14.06 All excavations shall be properly guarded with lights and barricades.
- 14.07 On state or town roads, utilize approved traffic patterns and signage.
- 14.08 Employees working in the public right-of-way shall be provided with and shall wear Class 3 DOT warning vests marked with or made of reflectorized or high-visibility material.

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- The standard lengths of ductile iron pipes are normally delivered on a flat-bed truck in packaged bundles. Each bundle is made up of tiers of pipe with 3" X 3" timbers as separators between the tiers. Each tier is prevented from sideways movement by wooden chock blocks which are secured to both ends of each separator. The package is then bound by two or more steel tension bands, one near each end of the package. The number of tiers per bundle and the number of pipes per tier are dependent on the diameter of the pipe being delivered.

Pipe Diameter (inches)	Number of Pipes	Number of Tiers
6	10	4
8	10	4
10	8	4
12	7	3
16	5	3
20	4	3
24	3	3

  - The bundles are attached to the bed of the truck using heavy chains. Normally, two bundles make up one load. The valves, bends, tees, and other fittings ranging from 6" to 24" in diameter which normally accompany the delivery of pipe can individually weigh anywhere from 50 lbs. to 2,000 lbs. and should be handled with power or mechanical equipment using slings, hooks, and/or a forklift truck.
  - 15.02 The Site:
    - Prior to a delivery of pipe, a Connecticut Water employee, or a contractor's representative will:
      1. Select a location close to the job site where the pipe will be unloaded. The storage location should have adequate space available and should be on firm, level ground.



2. Make arrangements, if required, for traffic control before the arrival of the load at the selected unloading area. Check the general area for overhead wires and pipes, catch basins, other utility structures, and nearby retaining walls.

Storage pipe normally be placed on timbers which should be positioned before the pipe is unloaded.

15.03 The Inspector:

Before the removal of the chains and steel bindings from the load, a Connecticut Water company or a contractor's representative who is trained and experienced in unloading similar pipe must:

1. Inspect the load to ensure that all wooden chock blocks are secured in place. Chock blocks should never be removed from the timber separators. If any of the chocks are missing, replacements must be made before the steel bindings are cut.

2. Check the pipe for damage that may have occurred in transit. Pipe showing evidence of damage, misloading, or faulty manufacture must be carefully inspected for abrasions, denting of the pipe ends, or cracks in the pipe wall which could result in joint leaks or cement lining damage.

3. Check that the flatbed of the truck is as level as possible before unloading. This reduces the possibility of movement of the pipe after the chains and steel bands have been removed. When the bed of the truck is not level, the possibility exists that central pipes may roll when the other pipes, or pipes, are removed. In this situation, additional chocks must be nailed to the separators under the central pipes to keep them from moving. This must be done before the chains or steel bindings are removed.

4. Check that the unloading equipment to be used is the correct type and size required for the weight and length of pipe to be unloaded. Unloading must never be attempted with faulty or inadequate equipment.

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15.04 The Unloading:

Hard hats and protective gloves must be worn by all employees. The only two acceptable methods of unloading are:

- a. Front end loader equipped with forks or a forklift truck.
b. Mechanical equipment with pipe hooks.

The pipe is ready to be unloaded only after a Company employee or a contractor's representative who is trained and experienced in unloading similar pipe is on the job site, has checked and secured the load, and the proper equipment is available.

While the truck driver removes the chains and cuts the steel bands, all other personnel should stand clear of the load. The steel bands should be cut using an appropriate type of steel cutting device. The pipe may be damaged if chocks or axes are used. The rear bundle should be completely unloaded before the chains or bands are removed from the front bundle.

- 1. Unloading with a forklift truck involves the removal of a set number of pipes each time until all pipes from that tier have been unloaded. Only personnel trained to use the forklift shall unload the pipe with a forklift. Procedures identified in forklift training (see Section 15) shall be followed.
2. Unloading with mechanical equipment and pipe hooks allows the removal of only one pipe at a time from the tier. A Company employee or a contractor's representative standing at the rear end of the bundle being unloaded, rolls forward the next pipe to be unloaded. This controls the balance of the remaining pipes on the tier.

15.05 The Site Structure:

Pipe to be stored at the jobsite will either be strung out along the job (if the pipe is to be installed shortly) or stacked in maximum use of storage space. The procedures are as follows:

- 1. Check the load before the chains or bindings are cut. Once the chains and steel bindings have been removed from the bundle to be unloaded, the truck must not move again until the entire bundle has been unloaded.

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15.07 Reloading Procedure:

It is often necessary to load previously stockpiled pipe and fittings on a low bed trailer for transport to or from a jobsite. The following procedure should be followed during reloading.

1. A Company employee or a contractor's representative who has training and experience in the reloading of pipe must be present for the entire operation.

2. All employees involved in the operation must wear protective gloves and hard hats.

3. A loader equipped with forks, forklift truck, or mechanical equipment with pipe hooks, are the only acceptable methods for reloading pipes.

4. Pipes to be loaded must be lifted and placed on timber separators on the truck bed. Each tier of pipes must be placed on timber separators. Chocks must be nailed to the end of each separator.

5. The number of tiers per bundle is dependent on the diameter of the pipe being transported:

Table with 2 columns: Pipe Diameter (inches), Number of Tiers. Values: 6-10 (4), 12 (3), 16 (2), 24 (2).

6. Each load is to consist of only two bundles. As with stacking operations, timber separators must be used between each tier. Chocks must be nailed to both sides of each separator.

7. Secure the pipe bundle to the truck bed with chains once the reloading procedure is complete.

15.08

The removal of transported pipe and products from the trailer at the site must follow the rules and safety procedures for individual pipe as outlined previously.

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2. Lay the pipe along the side of the road, off the pavement, and clear of any traffic.

3. Block the lengths of pipe placed on the ground to prevent rolling.

The truck must not move forward until the rear bundle is completely removed and the front bundle is secured and chained. Under no circumstances will single pipes be unloaded and placed on the truck progresses along the route.

15.06 Additional Procedures for Stacking Pipe:

All material stored in tiers, such as pipe, must be stacked and blocked to prevent sliding, falling, or collapse. Stored pipe must not be stacked higher than indicated in the following table:

Table with 2 columns: Pipe Diameter (inches), Number of Storage Tiers. Values: 6 (4), 8 (4), 10 (4), 12 (3), 16 (2), 24 (2).

The bottom tier should be kept off the ground on timber rails or concrete supports. Timber separators are to be placed between each tier and chocks nailed to each timber to prevent movement of the pipe. Temporary chocks are to be used until the tier or separator is full.

Pipe on all tiers should be alternated: bell/spigot, spigot/bell, etc.

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EXCAVATIONS, TRENCHES, AND PITS

Daily Trench Safety Field Reports (see Pages 33 and 34) are to be completed by the Competent Person (as described in OSHA 29CFR, 1926.201) for each trenching/excavating job prior to the entry of any employee into the trenching/excavation. Inspection and additional reports shall be conducted by the Competent Person after every rainstorm or other hazard increasing occurrence. Protection against slides and cave-ins shall be increased if necessary.

On water main projects that the Company is only inspecting, the Daily Trench Safety Field Report is to be completed while the inspector is on the jobsite. The Competent Person is to be notified if there are any safety violations. Completed forms are to be kept with the Daily Inspection forms.

The Competent Person must remain on the jobsite at all times. If for some reason he/she is unable to remain, he/she must designate another Competent Person on site to assume responsibility.

The Competent Person on the jobsite shall have available for ready access their Competent Person Card, the Daily Trench Safety Field Reports, a copy of the OSHA Excavation Regulations, copies of Material Safety Data Sheets for material that employees on the jobsite may come in contact with, and blank OSHA Inspection Report forms.

Prior to opening an excavation by mechanical means, it shall be determined whether underground installations, i.e., sewer, telephone, water, fuel, electric lines, etc. will be encountered, and if so, where such underground installations are located. Call Before You Dig procedures shall be followed. When the excavation approaches the utility, the location of such an installation, the exact location shall be determined, and when it is uncovered, proper supports shall be provided for the existing installation.

Protective helmets (hard hats) are to be worn at all times when working in and around a trench or excavation (see Section 7).

When using compressed air for excavating, goggles or spectacle-type safety glasses shall be worn by all personnel in the trench.

Compressed air tools shall not be left unattended while under pressure.

Compressed air tools shall not be turned on until the tool is placed solidly against the work.

Where oxygen deficiency (atmospheres containing less than 19.5% oxygen) or a hazardous atmosphere (as defined in OSHA 29CFR, 1926.101) is expected to exist, such as in excavations in landfill areas or where hazardous substances are stored nearby (fuel tanks, natural gas transmission lines), including all excavation sites greater than 4 feet deep, the atmosphere in the excavation shall be tested before personnel enter regardless if there is a suspected danger.

Always face machinery such as an excavator, backhoe, or trenching machine, and stay at least one shovel length from the maximum sweep of buckets or extended booms.

Always lay tools flat with the pointed or keen edge placed and so guarded to prevent any possible injury to workers or the public.

During night operations, adequate illumination must be used.

Dewatering of sediment laden water shall be done in a manner to prevent the sediment laden water from entering into a watercourse. Do not discharge trench wastewater directly into catch basins. Trench wastewater should be discharged into a sediment bag or bays before pouring to discharge wastewater into either a watercourse or catch basin.

No employee shall be permitted underneath loads handled by lifting or excavating.

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- 16.06 When employees are required to work in trenches four feet deep or more, an additional ladder or ramp, shall be provided and extend 25 feet of lateral travel. Ladders shall extend three feet above ground. Before climbing out of a trench, look in all directions for traffic dangers.
16.07 Trench bracing, shoring, or shielcing shall not be used as a ladder.
16.08 Excavate material in such a way that overhanging banks and overhanging equipment are avoided.
16.09 Excavated and other material shall be effectively stored at least two feet from the edge of the trench.
16.10 Shoring/shielcing, or shielcing is required in excavations as determined by OSHA requirements or the actual jobsite. If sloping the excavation, the maximum allowable slope is 1 1/2 horizontal to 1 vertical (34 degrees).
16.11 Sidewalks, pavements, and apparatus structures shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.
16.12 No employee is to remain in the trench while a trench box or shield is being moved.
16.13 Treat all wires uncovered in a trench as live wires until proven otherwise.
16.14 Employees working in the public right-of-way shall be provided with and shall wear Class 3 DOT warning vests marked with or made of reflective or high-visibility materials.
16.15 Keep a safe distance from other workers to avoid danger of striking them with tools.
16.16 Keep tools, equipment, and excavated material out of open traffic lanes and pedestrian ways. Remove pexbles, stones, and other debris from roadway where tires may pick them up and throw them causing injury or damage.
16.17 If the walls of a trench contain glass or other sharp objects, carefully remove them.

DAILY TRENCH SAFETY FIELD REPORT

Form for Daily Trench Safety Field Report with fields for To, Date/Time of Report, Project Identification, Project Owner, Contractor, Weather Conditions, Rainfall Amount, Call Before You Dig, and various safety checklists.

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Table with 3 columns: YES, NO, COMMENTS.

- 13. Change substance conditions from those anticipated?
14. Adequate means of entry and exit readily provided?
15. Ladders extended 3 feet above top of trench and tied off?
16. Hand lines have been used by all employees?
17. Hand lines extending 3 feet from end of excavation?
18. Spill kits available?
19. Warning equipment used?
20. MDD's on jobsite?
21. Used the permit system with the permit?
22. All flow-term trenches backfilled at day's end?
23. Know entry and rescue protection provided?
24. Observations:

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CONFINED SPACE ENTRY PROCEDURES

The Company has certain operations that require the entry into confined spaces. The Confined Space Entry procedure outlines the required procedure for performing work in these spaces.

A confined space means a space that:

- 1. Is large enough and so configured that an employee can bodily enter and perform assigned work.
2. Has limited or restricted means for entry or exit.
3. Is not designed for continuous employee occupancy.

A non-permit confined space means a confined space that does not contain, or with respect to atmospheric hazards, have the potential to contain any hazardous capable of causing death or serious physical harm.

A permit required confined space (permit space) means a confined space that has one or more of the following characteristics:

- 1. Contains or has a known potential to contain a hazardous atmosphere.
2. Contains a material with the reasonable probability for Engulfment of an Entrant.
3. Has an internal configuration such that an Entrant could be trapped or asphyxiated by inwardly converging walls or a floor which slopes downward and tapers to a smaller cross-section.
4. Contains any other recognized serious safety or health hazard.

Entry Supervisor - The person responsible for determining if acceptable entry conditions are present at a permit space where Entry is planned, for authorizing Entry, overseeing Entry operations, and terminating Entry as required. The Entry Supervisor must be the immediate Foreman/Chief Operator, in whose jurisdiction the permit space is located, or the next level of management as shown on the Company's Organizational Chart.

Hazardous Atmosphere - An atmosphere that may expose entrants to the risk of death, incapacitation, impairment of ability to self-rescue, injury, or acute illness by reason of oxygen deficiency or enrichment, flammability or explosivity, and/or toxicity.

Hot Work - Work within a permit space that produces arcs, sparks, flames, heat, or other sources of ignition.

Isolation - The process by which a permit space is removed from service and completely protected against the release of energy and material into the space.

LEL - Lower Explosive Limit - For this procedure, an atmosphere in which combustible gases exceed 10% of their Lower Explosive Limit is classified as hazardous.

Oxygen Deficient Atmosphere - An atmosphere containing less than 19.5% oxygen by volume.

Oxygen Enriched Atmosphere - An atmosphere containing more than 22.5% oxygen by volume.

Permit System - The Company's written procedure for preparing and issuing permits for Entry and for returning the permit space to service following termination of Entry.

Prohibited Condition - Any condition in a permit space that is not allowed by the permit during the period when Entry is authorized.

Retrieval System - The equipment (including a retrieval line, chest or fall body harness, wristlets, if appropriate, and a lifting device or anchor) used for non-entry rescue of persons from permit spaces.

Shall - Denotes a mandatory requirement.

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Should - A recommendation that is a sound safety and health practice; it does not denote a mandatory requirement.

Testing - The process by which the hazards that may confound entrants of a permit space are identified through testing. Testing includes specifying the tests that are to be performed in the permit space.

Confined Space Hazard Determination

The majority of the Company's confined spaces are manholes and vaults associated with the distribution of water. These include water storage tanks that require periodic cleaning, areas within our water treatment plants, pump stations, fuel storage tanks, meter pits, etc., that require periodic Entry. These are all considered confined spaces within the scope of this procedure. The potential hazards in these confined spaces include the lack of oxygen due to any number of causes such as poor ventilation and oxidation of metal surfaces. Because many of the confined spaces to be entered are at ground level or in public streets, there is the possibility of carbon monoxide entering the confined space from the passing traffic, the crew's truck, or improper use of ventilation equipment. Decomposing materials can be a source of hydrogen sulfide gas. Though our spaces are kept as clean as possible, there is always the potential for leaves or other material to enter the confined space. In some municipalities, natural gas is piped into residences and businesses and there is always the possibility of groundwater seepage containing some type of contamination that could be flammable. We, therefore, monitor for explosive vapors to detect these types of materials.

Another potential hazard is Engulfment by water entering the confined space. This could happen during a major failure of pipe or if a fitting was removed while the pressure was still on the line. Hot Work (see Section 21) such as welding introduces its own hazards due to the potential of using up the available oxygen and producing welding fumes.

Any Hot Work must be specifically authorized on the Entry Permit and continuous ventilation supplied. Exhaust ventilation may also be required for Hot Work.

STEP 2

Prior to entering the confined space, the Entrant shall sample under the cover using the remote probe procedure with the manometer. The cover shall not be removed until the reading for %LEL shows below the 10% explosive limit. If there are no holes in the cover, the cover shall be carefully removed and the %LEL reading will then be taken. The Entrant must ensure that the oxygen level is 15% or greater to assure the %LEL reading is accurate. Once the %LEL has been taken, the atmosphere is not above the LEL, they will remove the cover from the manway. After removal of the access cover, readings are to be taken slowly throughout the entire depth of the space to be entered. This is to be done with the sampling pump and flexible hose provided with the manometer. The sampling pump must be turned on prior to feeding the hose into the space. The hose is fed slowly into the space allowing the sampling pump sample time to draw air from all levels, and stopping as close as possible to the bottom of the space without going into water. During this time, the Entrant shall look and listen for any alarms signifying that something is out of range.

STEP 3

The Confined Space Pre-Entry Checklist (see Page 82) shall be completed before Entry into the confined space. This checklist shall be kept at the job site for the duration of the job.

If after testing the air, it is found to be within acceptable limits, the Entry may begin. During the Entry, the confined space will be continuously monitored using a Company provided monitoring instrument. If at any time during the Entry an alarm sounds, all Entrants are to immediately remove themselves from the confined space. If this happens, the confined space is not to be entered again until the problem has been determined and corrected. The only exception being if it is a low battery alarm. In this case, the space may be re-entered with a monitor with a charged battery.

17.04 Confined Space Entry Without Permit or Attendant Mechanical Ventilation

This procedure applies to confined spaces that have no non-atmospheric hazards. An adequate continuous supply of air shall be provided while work is performed in confined spaces under any of the following conditions:

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When persons are performing major maintenance work, there is an increase in the possibility that conditions in the confined space could change that could occur due to the type of activities being performed or from the material that Entrant brings into the confined space. Conversely, when a person enters a confined space to install, tighten, replace a packing nut, or clean a screen, the potential for the conditions in the confined space to change are minimal. However, both instances require air monitoring prior to Entry and continuously during Entry.

17.03 Confined Space Entry Without Permit or Attendant Non-Permit

When a confined space is to be entered to perform tasks that will not change the conditions of the confined space, and where the atmospheric conditions have been tested prior to, and continuously during, Entry, and where no previous problems in the confined space have been identified, this Entry will not require an Attendant or Permit. The Entrant will test the atmosphere prior to and continuously during Entry for levels of Oxygen (O2), Lower Explosive Limit (LEL), Carbon Monoxide (CO), and Hydrogen Sulfide (H2S).

Entry will not be allowed if the levels are not within acceptable ranges as shown on the Pre-Entry Checklist (see Page 82) or if the Entrant detects unusual odors, solvent smells, or there appears to be any condition that changes the confined space to the extent that it should now be considered a Permit Entry. The person involved in this Entry must have attended the Company's training program, and be proficient in the use of the gas detection monitoring equipment provided by the Company.

A step-by-step outline of this procedure follows:

STEP 1

The surrounding area shall be visually surveyed to avoid hazards such as exhaust from vehicles, falling objects, or drifting vapors.

STEP 2

Where the confined space is located in that portion of the public right-of-way open to vehicular traffic and/or exposed to seepage of gases.

Where a toxic gas or oxygen deficiency is found.

Where open flame or other Hot Work are used in the work procedure.

Where combustible or explosive gas vapors above 10% LEL have been taken by detector and subsequently reduced to a safe level by ventilation (natural or mechanical).

When a confined space is to be entered and any of the above criteria are met, the following step-by-step procedure must be followed for Entry:

STEP 1

The surrounding area shall be visually surveyed to avoid hazards such as exhaust from vehicles, falling objects, or drifting vapors.

STEP 2

Prior to removing the cover to the confined space, a barricade, consisting of warning cones as a minimum, shall be set up to alert people and traffic of personnel working in the area.

**STEP 3**  
Prior to entering the confined space, the Entrant shall sample under the cover using the remote probe provided with the monitors. The cover shall not be removed until the reading for %LEL shows below the 10% explosive limit. If there are no holes in the cover, the cover shall be carefully removed and the %LEL reading will then be taken. The Entrant must determine if the oxygen level is 15% or greater to assure the %LEL reading is accurate. Once the Entrant assured that the atmosphere is not above the LEL, the Entrant will remove the cover from the manway. After removal of the cover, readings are to be taken slowly throughout the entire depth of the space to be entered. This is to be done with the sampling pump and flexible hose provided with the monitor. The sampling pump must be turned on prior to feeding the hose into the space. The hose is fed slowly into the space allowing the sampling pump ample time to draw air from all levels, stopping as close as possible to the bottom of the space without going into water. During this time, the Entrant shall look and listen for any alarms signifying that something is out of range.

**STEP 4**  
Upon completion of the atmospheric testing, the results are to be recorded on the Pre-Entry Checklist (see Page 42). Next, a portable blower will be set up and the flexible hose is to be placed in the space as close as possible, in the vicinity of the area where the work is to be performed, without interfering with the work.

**CONFINED SPACE PRE-ENTRY CHECKLIST  
COMPLETE PRIOR TO ENTRY**

Serial No. of Instrument: \_\_\_\_\_ Date: \_\_\_\_\_

Location of Entry: \_\_\_\_\_

Purpose of Entry: \_\_\_\_\_

Any Previous Atmospheric Problems?: \_\_\_\_\_

Entrant(s): \_\_\_\_\_

Type of Ventilation Used: Natural ( ) Mechanical ( )

**Atmospheric Testing: Prior To and Continuously During Entry**

TEST	INITIAL READING	ACCEPTABLE RANGE	READING BEFORE ENTRY (LEL)	OK/ALARM
% OXYGEN	_____	19.5% - 23.5%	_____	YES NO -DONT ENTER
%LEL	_____	LESS THAN 10%	_____	YES NO -DONT ENTER
H2S SULFIDE (H2S)	_____	LESS THAN 10 ppm	_____	YES NO -DONT ENTER
CAR. MONOXIDE (CO)	_____	LESS THAN 35 ppm	_____	YES NO -DONT ENTER

Is the Work Authorized? YES ( ) NO ( ) If yes, continuous ventilation required.

When conditions are in compliance with the above requirements and there is no reason to believe conditions may change adversely then entry may proceed. If conditions are not in compliance with the above requirements then the Permit Entry Procedure (Section 17.05) must be followed.

Time of Entry: \_\_\_\_\_ Signature of Entrant(s): \_\_\_\_\_

Time of Exit: \_\_\_\_\_

**STEP 2**  
Prior to entering the confined space, the Entrant shall sample under the cover using the remote probe provided with the monitors. The cover shall not be removed until the reading for %LEL shows below the 10% explosive limit. If there are no holes in the cover, the cover shall be carefully removed and the %LEL reading will then be taken. The Entrant must determine if the oxygen level is 15% or greater to assure the %LEL reading is accurate. Once the Entrant has assured that the atmosphere is not above the LEL, the Entrant will remove the cover from the manway. After removal of the access cover, readings are to be taken slowly throughout the entire depth of the space to be entered. This is to be done with the sampling pump and flexible hose provided with the monitor. The sampling pump must be turned on prior to feeding the hose into the space. The hose is fed slowly into the space allowing the sampling pump ample time to draw air from all levels, stopping as close as possible to the bottom of the space without going into water. During this time, the Entrant shall look and listen for any alarms signifying that something is out of range. Upon completion of sampling from the lowest level in the space, the peak readings are to be recorded on the Permit form.

If all readings are within acceptable range, the Entry may begin (proceed to STEP 5).

If any of the readings are outside of the acceptable range, the personnel shall set up a portable blower supplied by the Company and will feed the flexible hose well into the space, as close to the bottom as possible without interfering with the work or entering any water residual in the hole. If the space contains a significant amount of water, the water will be pumped out from the space prior to ventilation and entry.

**STEP 3**  
The space will be ventilated for 15 minutes, after which time another set of readings are to be taken in the same way as described in STEP 2.

**STEP 6**  
Upon completion of the Entry, all materials are to be removed from the permit space. The cover is to be replaced and the permit will be cancelled by the Entry Supervisor. Under no circumstances are anyone to re-enter the permit space again unless they receive another Entry Permit.

If all of the readings are within acceptable range, the Entry may begin. If any of the readings are outside of the acceptable range, the permit space will be ventilated for an additional 30 minutes and a test of the atmosphere will be repeated. If at this point the space is still not safe to enter, the Entry Supervisor shall be notified and Entry will be made until such time as the Entry Supervisor makes an on-site visit, determines the cause of the problem, and corrects the atmosphere in the permit space for acceptable re-entry.

**STEP 5**  
Once the air has been tested and is satisfactory, all Entrants to the permit space shall attach retrieval lines to their harnesses provided by the Company. These retrieval lines shall be attached to a lifting device or anchor that can be used for non-emergency rescue. If the number of Entrants is such that retrieval lines would cause a hazard, they do not have to be attached to the Entrants, but will be attached to the lifting device or anchor and available for use. The Attendant shall remain outside of the permit space and shall keep in voice and/or visual contact with the Entrants at all times. If for some reason the Attendant has to move away from the permit space, he/she shall have the Entrants remove themselves from the permit space. During the entry time of the Entry, there shall be a Company provided monitoring instrument monitoring the atmosphere in the vicinity of the Entrants. At NO time is there to be an Entrant in the permit space without a monitoring instrument monitoring the atmosphere in the permit space. If at any time the instrument alarm sounds, ALL Entrants shall immediately remove themselves from the permit space until such time as it is determined why the instrument alarm sounded and what specific actions must be taken to correct the situation. No one is to re-enter the space until the air is re-tested and the results are satisfactory. If during the Entry the Attendant feels that there is an unsafe condition, either in the permit space or around the permit space, he/she shall instruct all Entrants to exit the permit space immediately. The Attendant's sole purpose is to observe that no Entrants in the permit space are overcome, or that no event outside of the permit space presents a problem to the Entrants in the permit space. He/she is to NO time to enter the permit space, even to assist in rescue. Instead, the Attendant shall summon help and only assist to rescue attempts from outside the permit space.

**PERMIT SPACE ENTRY PERMIT  
COMPLETE PRIOR TO ENTRY**

Serial No. of Instrument: \_\_\_\_\_ Emergency Phone No. \_\_\_\_\_

Location of Entry: \_\_\_\_\_ Time of Entry: \_\_\_\_\_

Purpose of Entry: \_\_\_\_\_

Any Previous Atmospheric Problems?: \_\_\_\_\_

Entry Supervisor: \_\_\_\_\_

**SPECIAL REQUIREMENTS**

Perform all checked steps, provide checked equipment. The Entry Supervisor shall check any additional steps that are required.

( ) Guard Opening ( ) Harness on all Entrants ( ) Other - List \_\_\_\_\_

( ) Retrieval Lines ( ) Energy Source Isolated ( ) Purge With Air \_\_\_\_\_

( ) Continuous Media Ventilation ( ) Continuous Monitoring \_\_\_\_\_

( ) Attendant Present ( ) Lockout/Tagout \_\_\_\_\_

**Atmospheric Testing: Prior To and Continuously During Entry**

TEST	INITIAL READING	ACCEPTABLE RANGE	READING BEFORE ENTRY (LEL)	OK/ALARM
% OXYGEN	_____	19.5% - 23.5%	_____	YES NO -DONT ENTER
%LEL	_____	LESS THAN 10%	_____	YES NO -DONT ENTER
H2S SULFIDE (H2S)	_____	LESS THAN 10 ppm	_____	YES NO -DONT ENTER
CAR. MONOXIDE (CO)	_____	LESS THAN 35 ppm	_____	YES NO -DONT ENTER

Is the Work Authorized? YES ( ) NO ( ) If yes, continuous ventilation required.

Time of Entry: \_\_\_\_\_ Time of Exit: \_\_\_\_\_

We have reviewed the work authorized by this permit and the information contained herein. Instructions and safety procedures have been reviewed and are understood.

Attendant: \_\_\_\_\_ Signature: \_\_\_\_\_

Entrant: \_\_\_\_\_ Signature: \_\_\_\_\_

Entrant: \_\_\_\_\_ Signature: \_\_\_\_\_

ENTRY COMPLETED AND PERMIT CANCELLED Signature: Entry Supervisor: \_\_\_\_\_

This permit is to be kept in the jobfile for the duration of the work.

**IN CASE OF EMERGENCY CALL 911 AND/OR RADIOTELEPHONE THE DISPATCHER AND/OR CALL THE EMERGENCY TELEPHONE NUMBER ABOVE.**

**17.05 Confined Space Permit Entry Procedures**

When a confined space is to be entered does not comply with either the Non-Permit Confined Space Procedure (Section 17.03) or the Mechanical Ventilation Procedure (Section 17.04), then the Permit Entry Procedure must be followed.

An Entry Permit (see Page 47) is to be completed and signed by the Entry Supervisor. The Entry Supervisor designates who shall be the Attendant (the person in charge of the Entry, and who the Entrant(s) shall be. The Attendant shall remain at the scene of the Entry and be the individual in charge of the Entry. If this Attendant must leave the scene, then a new Attendant designated by the Entry Supervisor is to take charge of the Entry. A list of Entry Supervisors, Attendants, and Entrants is to be kept in file in the Company's personnel office.

Whenever an Entrant is within the permit space, there shall be an Attendant stationed outside of the permit space who shall at all times keep in voice and/or visual contact with the Entrant(s). This means if one person is needed to work in the permit space, a second person will be there as an Attendant for the Entrant.

During the Entry, the atmosphere of the permit space shall be continuously monitored using a Company provided instrument worn by one or more of the Entrants. For example, if three people are in the permit space and one or two leave, the instrument must remain with the last person in the permit space. If at any time during the Entry an alarm sounds, all Entrants shall immediately remove themselves from the permit space. If during the Entry the Attendant feels that there is an unsafe condition, either in the permit space or around the permit space, he/she will instruct all Entrants to exit the permit space immediately. The Attendant's sole purpose is to observe that no personnel in the permit space are overcome, or that no event outside of the permit space presents a hazard to the people in the permit space. The Attendant is at NO time to enter the space, even to assist in rescue. Instead, he/she is to summon help and to assist in rescue attempts from outside the permit space. The Company does not have an in-house rescue team, but does rely on the services provided through its local Emergency Medical Services (EMS) that would be contacted by calling 911.

Personnel entering the permit space shall wear a harness with retrieval lines available for each individual. The retrieval line shall be secured to a lifting device or anchor that can be used for non-emergency rescue. If due to the number of Entrants, attached lines would cause an additional problem, a harness will be worn but the lines do not have to be attached. Lines shall be available to be attached to a lifting device if an emergency occurs. There shall never be more Entrants permitted in the space than are absolutely necessary to perform the work, except for training purposes. If during an Entry, emergency assistance is needed, the Attendant shall immediately contact the Company by use of a vehicle radio. The person receiving the call shall immediately contact the appropriate EMS system. This number is located in the upper right hand corner of the permit. If a mobile phone is available in a vehicle, or another phone is available on or near the site, the Attendant may call for help prior to contacting the Company. The Company must also be notified of the incident. In NO instance shall anyone else physically enter the space unless they are equipped with the proper rescue equipment specific to the emergency situation.

An Entry Permit (see Page 47) must be completed prior to entering. A step-by-step outline of this procedure follows:

**STEP 1**  
The surrounding area shall be visually surveyed to avoid hazards such as exhaust from vehicles, falling objects, or drifting vapors.

The crew will then set up a barricade consisting of warning cones as a minimum around the manhole, if applicable. This is to alert people and traffic of the removed cover and of personnel working in the area.

Personal entering the permit space shall wear a harness with retrieval lines available for each individual. The retrieval line shall be secured to a lifting device or anchor that can be used for non-emergency rescue. If due to the number of Entrants, attached lines would cause an additional problem, a harness will be worn but the lines do not have to be attached. Lines shall be available to be attached to a lifting device if an emergency occurs. There shall never be more Entrants permitted in the space than are absolutely necessary to perform the work, except for training purposes. If during an Entry, emergency assistance is needed, the Attendant shall immediately contact the Company by use of a vehicle radio. The person receiving the call shall immediately contact the appropriate EMS system. This number is located in the upper right hand corner of the permit. If a mobile phone is available in a vehicle, or another phone is available on or near the site, the Attendant may call for help prior to contacting the Company. The Company must also be notified of the incident. In NO instance shall anyone else physically enter the space unless they are equipped with the proper rescue equipment specific to the emergency situation.

An Entry Permit (see Page 47) must be completed prior to entering. A step-by-step outline of this procedure follows:

**STEP 1**  
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The crew will then set up a barricade consisting of warning cones as a minimum around the manhole, if applicable. This is to alert people and traffic of the removed cover and of personnel working in the area.

**RESPIRATORY PROTECTION**

- 18.00** Follow the written Connecticut Water Respiratory Protection Program. Only authorized personnel shall use respirators.
- 18.01** It is your duty to know the correct procedure for the proper use of respirators. If you are not sure, ask your supervisor.
- 18.02** Respiratory hazards include: (1) nuisance dusts such as cement, hydrated lime, (2) mists and fumes from paints, chemicals, and heated metals, (3) vapors and gases such as chlorine, ammonia, and carbon monoxide. Use an air-purifying respirator if you should encounter any one of these conditions.
- 18.03** The wearer should have the contaminated area immediately on detecting the odor of chlorine, or an experiencing dizziness or difficulty in breathing; these are indications that the respirator is not functioning properly, that the chlorine concentration is too high, or that sufficient oxygen is not available.
- 18.04** Do not enter a contaminated area until you are sure that the contaminant in the respirator is the proper one for the contaminant or contaminants present.
- 18.05** Respirators and air purifying cartridges are to be kept in the containers provided they are defective respirator to your supervisor and to take it out of service immediately.

- 19.01** All electrical work performed will follow the guidelines listed in the NFPA 70E Standard for Electrical Safety in the Workplace, National Electrical Code and OSHA 29 CFR 1910 Subpart S.
- Proper PPE guidelines will be followed identified in the NFPA 70E Article 130.7 Hazard Risk Category Classification Table. These guidelines are reserved for only "Qualified Individuals". Only qualified individuals are allowed to work on live electrical equipment in the company.
- The definition of a "Qualified Person" is one who has the skills and knowledge to the construction and operation of the electrical equipment and installations and has received Connecticut Water Company sponsored electrical and ARC Flash safety training or is a licensed electrician who has attended all OSHA sponsored ARC Flash Safety Certifications. In addition to the training the "Qualified Person" will be issued the Personal Protective Equipment (PPE) and have been evaluated and deemed competent to work on equipment with voltages less than 240Volts. Working on voltages above 240volts is forbidden and reserved for individuals who received formal training such as licensed electricians and the Control Systems Services group.

**LOCKOUT/TAGOUT PROCEDURES**

- 20.00** The Occupational Safety and Health Administration's (OSHA) Lockout/Tagout Safety Standard is designed to prevent machines from accidentally restarting while workers are performing maintenance or repair.
- This procedure establishes the minimum requirements for the lockout or tagout of energy-isolating devices. It shall be used to ensure that the machine or equipment is isolated from all potential hazardous energy, and locked out or tagged out before employees perform any servicing or maintenance activities where the unexpected energization, start-up or release of stored energy could cause injury.
- Appropriate employees shall be instructed by their immediate supervisor in the safety significance of the lockout or tagout procedures. Each new or transferred employee who is affected by this and other employees whose work operations are or may be in the area shall be instructed in the purpose and use of the lockout or tagout procedure, and view the safety video, "Lockout/Tagout Protection".
- Tagout devices shall warn against hazardous conditions if the equipment is energized and shall include a legend such as "DO NOT OPERATE".
- Protective Material and Hardware: Locks, tags, chains, wedges, key blocks, and self-locking fasteners shall be provided by the Company for isolating, securing, or blocking equipment from energy sources. Lockout devices and tagout devices shall be singularly identified, shall be the only devices used for controlling energy, and shall not be used for other purposes.
- Standardized: Lockout and tagout devices shall be standardized within the facility in at least one of the following criteria: color (red, blue, or size).
- Identifiable: Lockout and tagout devices shall indicate the identity of the employee applying the device.
- If more than one padlock is provided, they shall have different keys so that the lock may not be removed by an unauthorized person.

- 20.01** Preparation for Lockout or Tagout
- The person performing the work and lockout/tagout is to make a survey to locate and identify all isolating devices to be certain which one(s) or other energy-isolating devices apply to the equipment to be locked or tagged out. More than one energy source (electrical, mechanical, or others) may be involved.
- Sequence of Lockout or Tagout Procedure:
  1. The person performing the work and lockout/tagout shall notify all affected employees that a Lockout or Tagout system is going to be utilized and the reason for it. The authorized employee shall know the type and magnitude of the energy that the machine or equipment utilizes and shall understand the accompanying hazards.
  2. If the machine or equipment is STOPPING, shut it down by the normal stopping procedure (depress STOP button, open circuit breaker, etc.).
  3. Operate the switch, valve, or other energy-isolating device(s) to that the equipment is isolated from its energy source(s). Stored energy (such as that in springs, elevated machine members, rotating flywheels, hydraulic systems, and air, gas, steam, or water pressure, etc.) must be dissipated or restrained by methods such as repositioning, blocking, bleeding down, etc.
  4. Lockout and/or Tagout the energy-isolating device(s) with assigned individual lock(s) or tag(s).
  5. After ensuring that no personnel are exposed, and as a check on having disconnected the energy source(s), operate the push button or other normal operating control(s) to make certain the equipment will not be energized.
- CAUTION: Return operating control(s) to Neutral or Off position after the test.
- 6. The equipment is now locked out or tagged out.

**HOT WORK POLICY**

- 21.00** The purpose of the Hot Work policy is to comply with the Occupational Safety and Health Administration (OSHA) 29 CFR 1910.252, general requirements for welding, brazing, and cutting, and to institute safe work practices that will ensure protection to personnel and property.
- 21.01** Scope
- The Hot Work policy applies to any stationary or portable device used in any welding, cutting, brazing, or any other active involuntarily flame sparks, or other ignition sources which may cause smoke or fire or which may trigger detection systems. This program also applies to all Hot Work operations on or near a process regulated by the OSHA Process Safety Management Standard.

**Hazard Risk Table**

Hazard Risk Task	Required Action for 240v and below	Don Schumacher Safety Engineer 860-664-6067	Paul Martuzzi Control Systems Supervisor 860-664-6084
Turning on Circuit breakers with covers on or off	Wearing of Safety glasses		
Opening of hand covers to expose live equipment	Wearing of Safety glasses and electrical safety gloves		
Voltage testing work on energized equipment	Wearing of Safety glasses and electrical safety gloves		
Removal of hot/cold covers on live equipment	Wearing of Safety glasses and electrical safety gloves		
Removal of circuit or fused switches	Wearing of Safety glasses and electrical safety gloves		
<b>Hazard Risk Task</b>	<b>Required action 240v up to 600v ac</b>		
Turning on Circuit breakers with covers on	Wearing of Safety glasses		
Turning on Circuit breakers with covers off	Wearing of Safety glasses and electrical safety gloves		
Working on energized equipment	ARC FLASH suit with goggles & hearing protection PPE rated 2+ Licensed Electrician w/ARC Flash Training only		
<b>Required action 600v ac and up</b>	<b>Licensed Electrician w/ARC Flash Training</b>		
Working on energized equipment	Licensed Electrician w/ARC Flash Training		

Listed below are the Hazard Risk and PPE requirements listed in the NFPA-70E, Connecticut Water Company is adhering to this guideline and requires those who wish to continue to work on or around electrical equipment within the company to do the same.

Any questions on clarification of hazards or personal protective equipment required should be directed to the Safety Engineer Don Schumacher or the Control Systems Supervisor Paul Martuzzi.

**19.02 Ground Fault Interrupters**- Shall be used when using any type of electrical device such as power equipment, heaters, external lighting etc. . . .

**19.03 Safety Tips and Guidelines when working around or near electricity.**

**Basic Electrical Safety Tips**

- Treat all wires as live wires
- Unless you are a qualified electrician do not attempt electrical repairs
- Never use electrical tools on damp ground or when standing in water
- Report all suspected questionable electrical hazards to your supervisor.
- Never place an antenna near power lines
- Keep a safe distance from paid motor manufacturers
- Never insert anything (especially metal) into an electrical appliance (such as a toaster, heater, etc. . .)
- Do not overload electrical outlets with too many electrical plugs. Buy one surge protector with many outlets instead of "daisy-chaining" smaller power splitters
- Inspect tools and appliances for wear and damage prior to use
- Use electrical tape for power cord management, do not use staples
- Always use the correct size fuse never use a fuse with a larger amperage allowance than the original
- Never use ladders to perform work near or over head power lines
- If you have a bad feeling about some concerning electricity, stay away!
- Know where breakers and electrical boxes are in case of an emergency
- Label circuit breakers clearly
- Do not use electrical outlets or cords with exposed wiring
- Do not touch a person or electrical appliances in the event of an electrical accident. Always disconnect the circuit first.
- Do not clean tools with flammable or toxic solvents if being used around electrical devices.
- Visually inspect electrical cords before putting them into use
- Never allow equipment or vehicles to run over electrical cords.

**Fire Watch:**  
A Fire Watch person shall be required whenever welding or cutting is performed in locations where other than a minor fire might develop, or any of the following conditions exist:  
1. Appreciable combustible material, in building construction or contents, closer than 35 feet to the point of operation.  
2. Appreciable combustibles are more than 35 feet away but are easily ignited by sparks.  
3. Wall or floor openings within a 35-foot radius expose combustible material in adjacent areas including concealed spaces in walls or floors.  
4. Combustible materials are adjacent to the opposite side of metal partitions, walls, ceilings, or roofs, and are likely to be ignited by conduction or radiation.

4. Assume that a Fire Watch person is assigned and this is their only duty during the Hot Work. The Fire Watch must be trained in the proper use of a fire extinguisher, and should not pressure the extinguisher or break the seal unless a fire actually occurs.  
5. Periodically monitor the atmosphere with the atmospheric monitor. If the combustible/flamable gas exceeds 10% LEL, the job must be stopped until the cause for the increased LEL is determined and corrected.  
**Note:** When Hot Work is required in a Confined Space, reference must be made to the Connecticut Water Confined Space Program (see Section 17).  
6. Signing the permit acknowledges that all preparations for the Hot Work have been made. The permit shall be visibly posted near the job-site until the work is completed.  
7. The Fire Watch permit shall remain on site for 30 minutes following completion of the Hot Work to ensure there has been no spread of sparks or heat and the facility is ready to return to normal service.

**METER READING/CHANGING**  
23.00 Before starting on a route, check safety equipment to make sure all equipment is in proper working condition and review the route log, and/or meter reader instructions by you, for any potential hazards such as dogs.  
23.01 Exercise caution before entering any property, checking for dogs or other hazards. Do not enter the property at any time you have concerns for your personal safety. Walking and/or climbing fences or hedges will be considered a violation of the Safety Rules.  
23.02 Snow, ice, rain, or foreign matter make surfaces slippery and/or dangerous. Extra caution and good judgment must be exercised to avoid slips and falls.  
23.03 Always brace yourself before attempting to open an outside cellar door. Make sure door is secured before entering.  
23.04 Rusty or corroded catches or hasps must be handled carefully.  
23.05 Exercise extreme caution when walking on polished or waxed floors. Throw rags aside easily when stepped on. Be alert and avoid falls.  
23.06 Be sure to use a flashlight when entering dim or dark places, as it takes time for eyes to adjust to changing light conditions.  
23.07 Exercise extreme caution when descending cellar stairs. Use handrails whenever possible. Look for slippery, worn, or broken stairs. Beams, benches, mops, waspener, bottles, etc., are frequently found on cellar steps. Be careful to avoid falls or injury.  
23.08 Do not enter a cellar if the basement is flooded. Verify area is safe from electrical hazards before proceeding.  
23.09 When in cellars, be on the alert for overhead pipes, cabinets, shelves, debris, sump pits, furnace pits, protruding furnace burners, etc.; they can cause serious injury. Bump caps are available if desired.  
23.10 A jumper cable must always be used when removing a meter.

23.11 When removing a Meter from a Reading Device:  
1. Turn the meter off and remove the cover before verifying no wires or pipes will be hit by the drill. Drill from the outside to the inside where possible.  
2. Be sure drills are suitably charged and drill bits are not worn out.  
3. If there is any doubt of damage to wiring, notify a supervisor immediately.

**21.02 Hot Work General Information**  
The individual in charge of authorizing Hot Work should determine which operations require a written permit (see Page 56), and if applicable must follow all rules regarding confined spaces, and areas where highly hazardous chemicals are located.  
**21.03 Hot Work Guidelines**  
The following guidelines should be followed for all Hot Work operations:  
1. The person in charge of the job shall be knowledgeable of Hot Work requirements and the tasks being performed.  
2. Work and equipment should be relocated outside hazardous areas when possible.  
3. Conduct a pre-job safety meeting to plan the job and discuss all safety aspects with employees or contractors involved. Review permit with everyone involved.

**21.04 Hot Work Record Keeping Requirements:**  
Completed Hot Work Permits (see Page 56) shall be kept on file at each facility for a minimum period of one year following termination of the Hot Work.  
**21.05 Hot Work References:**  
OSHA 29CFR 1910.252-257  
ANSI Z490.1 Safety in Welding and Cutting  
NFPA 30.51-B

**HOT WORK PERMIT**

To be completed by person requesting permit

Required Precautions Checklist

Do Work to be performed by:  
 Welding, Soldering  
 Cutting  
 Other

DATE: \_\_\_\_\_ TIME: \_\_\_\_\_ PERMIT NO: \_\_\_\_\_

LOCATION: PLANT BUILDING \_\_\_\_\_

COUNTY/FLOOR: \_\_\_\_\_

NAME OF PERSON CONDUCTING WORK: \_\_\_\_\_

NATURE OF JOB: \_\_\_\_\_

DATE OF CONSTRUCTION SUPERVISOR OR COMPANY SUPERVISOR: \_\_\_\_\_

NAME OF PERSON AUTHORIZING PERMIT: \_\_\_\_\_

PERMIT EXPIRES: \_\_\_\_\_ DATE: \_\_\_\_\_ TIME: \_\_\_\_\_ AM/PM

NOTE: The person in charge of the job should be knowledgeable of the Hot Work requirements, and the task being performed.

**MATERIAL SAFETY DATA SHEETS (MSDS)**  
22.00 Material Safety Data Sheets (MSDS) are provided to the Company by all suppliers who manufacture or distribute a product which may be hazardous. MSDS contains the following information:  
1. Fire and Explosion Hazard.  
2. Health Hazard Data.  
3. Emergency and First Aid Procedures.  
4. Special Protection Information.  
5. Precautions Taken During Handling and Storage.  
6. Spill and Leak Procedures.  
Complete copies of MSDS are kept in Region Offices and Water Treatment Plants, and are available to any employee upon request. Job related MSDS Sheets may be available at construction site and/or in vehicles.  
22.01 All employees shall follow the safety precautions and material handling safety instructions for materials as indicated on the MSDS, including the use of Personal Protection Equipment (PPE).  
22.02 Any employee working with chemicals shall be trained in safe materials handling and hazard communications in accordance with the OSHA Safety Standard, Section 1910.1200. If an employee is not trained in and familiar with the proper handling, he/she shall not handle the chemical until they receive such training.  
22.03 In the event of exposure to a chemical, employee shall follow first aid procedures and seek medical help.

**MELTING OPERATIONS**  
24.00 Conduct compound joint melting operations at such a location and in such a manner that the actual contact with or spillage of the hot material is minimized. Take special precautions whenever the work is performed in an area where the spillage could endanger workers in vaults, trenches, or other excavations. Personal protective safety equipment must be used at all times (see Section 7).  
24.01 Do not put wet material or water into joint compounds, or add large quantities of such compounds to the melting pot suddenly, as such action is the frequent cause of explosions of the melting pot.  
24.02 While joint compounds are melting, always heat the ladle to evaporate any moisture that might be present on it.  
24.03 When working with joint compounds, be sure your footing is secure, wear gloves, face shields, high-top shoes, and long sleeved shirts with the sleeves rolled down.  
24.04 Be sure that the path of travel from the joint compound melting operations to the point where the material is to be poured is unobstructed. Warn all workers along the route to be alert and stand clear when hot material is being carried.  
24.05 When melting sulphur compound, avoid unnecessary contact with the fumes of either the primer or the compound.  
24.06 Use approved type buckets to raise or lower buckets containing melted compounds.  
24.07 Never leave the melting pot unattended when the contents are hot.  
24.08 Location of fire extinguishers provided for melting operations shall not exceed 100 feet in any direction from the melting operation.

**FALL PREVENTION AND PROTECTION**  
Connecticut Water Company  
92 West Main Street  
Cheshire, Connecticut 06013  
Fall Prevention/Protection Plan  
Issued: June 2010

**29 CFR 1926, Subpart M**

**Fall Prevention/Protection Program**

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**Fall Protection Program**  
for  
**Connecticut Water Company**

**I. OBJECTIVE:**  
The objective of the Connecticut Water Company Fall Protection Program is to identify and evaluate fall hazards to which employees will be exposed, and to provide specific training as required by the Occupational Safety and Health Administration (OSHA) Fall Protection Standard, 29 CFR 1926, Subpart M.

**II. POLICY**  
It is the policy of The Connecticut Water Company to protect its employees from occupational injuries by implementing and enforcing safe work practices and appointing a competent person(s) to manage the Fall Protection Program. The Connecticut Water Company Fall Protection Program shall comply with the OSHA requirements. A copy of the OSHA Fall Protection Standard shall be made available to all employees, and may be obtained from The Connecticut Water Company Safety Committee.

**III. ASSIGNMENT OF RESPONSIBILITY**  
A. Employer  
It is the responsibility of The Connecticut Water Company to provide fall protection to affected employees, and to ensure that all employees understand and adhere to the procedures of this plan and follow the instructions of The Connecticut Water Company Safety Committee.  
B. Program Manager  
It is the responsibility of The Connecticut Water Company Safety Committee Fall Prevention/Protection Sub-Committee Chair as the Fall Protection Program Manager to implement this program by:  
1. performing routine safety checks of work operations;  
2. enforcing The Connecticut Water Company safety policy and procedures;  
3. correcting any unsafe practices or conditions immediately;

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6. Connected on each side to a guardrail system or wall.  
7. Erected between six (6) feet and 25 feet from an unprotected edge, except in the following cases:  
a. when working with precast concrete members: between six (6) feet and 40 feet from the leading edge, or half the length of the member being erected, whichever is less; or  
b. when performing overhead bricking or related work: between ten (10) feet and 15 feet from the working edge.

**VI. EXCAVATIONS**  
Fall protection will be provided to employees working at the edge of an excavation that is six (6) feet or deeper. Employees in those areas are required to use the fall protection systems as designated in this program.  
A. Excavations that are six (6) feet or deeper shall be protected by guardrail systems, fences, barricades, or covers.  
B. Walkways that allow employees to cross over an excavation that is six (6) feet or deeper shall be equipped with guardrails.  
**VII. FALL PROTECTION SYSTEMS**  
A. Covers  
1. All covers shall be secured to prevent accidental displacement.  
2. Covers shall be color-coded or bear the markings "HOLE" or "COVER".  
3. Covers located in roadways shall be able to support twice the axle load of the largest vehicle that might cross them.  
4. Covers shall be able to support two (2) times the weight of employees, equipment, and materials that might cross them.  
5. d. be strong enough to withstand twice the potential impact energy of an employee free falling six (6) feet (or the free fall distance permitted by the system, whichever is less);  
e. be inspected prior to each use for damage and deterioration; and  
f. be removed from service if any damaged components are detected.  
2. All components of a fall arrest system shall meet the specifications of the OSHA Fall Protection Standard, and shall be used in accordance with the manufacturer's instructions.  
a. The use of non-locking snap hooks is prohibited.  
b. Dee-rings and locking snap hooks shall:  
i. have a minimum tensile strength of 5000 pounds; and  
ii. be proof-tested to a minimum tensile load of 3600 pounds without cracking, breaking, or suffering permanent deformation.  
c. Lifelines shall be:  
i. Designed and installed under the supervision of a qualified person;  
ii. protected against cuts and abrasions; and  
iii. equipped with horizontal lifeline connection devices capable of locking in both directions on the lifeline when used on suspended scaffolds or similar work platforms that have horizontal lifelines that may become vertical lifelines.  
d. Self-retracting lifelines and lanyards must have ropes and straps (webbing) made of synthetic fibers, and shall:  
i. sustain a minimum tensile load of 3600 pounds if they automatically limit free fall distance to two (2) feet; or  
ii. sustain a minimum tensile load of 5000 pounds (includes rip stitch, tearing, and deforming lanyards).  
e. Anchorage must support at least 5000 pounds per person attached and shall be:  
i. designed and installed under the supervision of a qualified person; and  
ii. independent of any anchorage used to support or suspend platforms.

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**B. Guardrail Systems**  
Guardrail systems shall be erected at unprotected edges, ramps, runways, or holes where it is determined by competent person that erecting such systems will not cause an increased hazard to employees. The following specifications will be followed in the erection of guardrail systems. Top rails shall be:  
1. at least 3/4 inch in diameter (steel or plastic handrail is unacceptable);  
2. flagged every six (6) feet or less with a high visibility material if wire rope is used;  
3. inspected by a competent person as frequently as necessary to ensure strength and stability;  
4. forty-two (42) inches (plus or minus three (3) inches) above the walking/working level;  
5. adjusted to accommodate the height of lifts, if they are to be used.  
Midrails, screens, mesh, intermediate vertical members, and solid panels shall be erected in accordance with the OSHA Fall Protection Standard.  
Gates or removable guardrail sections shall be placed across openings of hoisting areas or holes when they are not in use to prevent access.  
**C. Personal Fall Arrest Systems**  
1. Personal fall arrest systems shall be issued to and used by employees as determined by a competent person and may consist of anchorage, connectors, body harness, deceleration device, lifeline, or suitable combinations. Personal fall arrest systems shall:  
a. limit the maximum arresting force to 1800 pounds;  
b. be rigged so an employee cannot free fall more than six (6) feet or contact any lower level;  
c. anchor an employee to a complete stop and limit the maximum deceleration distance traveled to three and a half (3 1/2) feet;  
d. Positioning Device Systems  
Body belt or body harness systems shall be set up so that an employee can free fall no farther than two (2) feet, and shall be secured to an anchorage capable of supporting twice the potential impact load or 3600 pounds, whichever is greater. Requirements for snap hooks, dee-rings, and other connectors are the same as detailed in this Program under Personal Fall Arrest Systems.  
**E. Safety Monitoring Systems**  
In situations when no other fall protection has been implemented, competent persons shall monitor the safety of employees in these work areas. The competent person shall be:  
1. competent in the recognition of fall hazards;  
2. capable of warning workers of fall hazard dangers;  
3. operating on the same walking/working surfaces as the employees and able to see them;  
4. close enough to work operations to communicate orally with employees; and  
5. free of other job duties that might distract them from the monitoring function.  
No employees other than those engaged in the work being performed under the Safety Monitoring System shall be allowed in the area. All employees under a Safety Monitoring System are required to promptly comply with the fall hazard warnings of the competent person.  
**F. Safety Net Systems**  
1. Safety net systems must be installed no more than 30 feet below the walking/working surface with sufficient clearance to prevent contact with the surface below, and shall be installed with sufficient vertical and horizontal clearance to prevent contact with the OSHA Fall Protection Standard.

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4. training employees and supervisors in recognizing fall hazards and the use of fall protection systems;  
5. maintaining records of employee training, equipment issue, and fall protection systems used at The Connecticut Water Company facilities and jobsites; and  
6. investigating and documenting all incidents that result in employee injury.

**C. Employees**  
It is the responsibility of all employees to:  
1. understand and adhere to the procedures outlined in this Fall Protection Program;  
2. follow the instructions of The Program Manager;  
3. bring to management's attention any unsafe or hazardous conditions or practices that may cause injury to either themselves or any other employees; and  
4. report any incident that causes injury to an employee, regardless of the nature of the injury.

**IV. TRAINING**  
A. All employees who may be exposed to fall hazards are required to receive training on how to recognize such hazards, and how to minimize their exposure to them. Employees shall receive training as soon after employment as possible, and before they are required to work in areas where fall hazards exist.  
B. A record of employees who have received training and training dates shall be maintained by The Program Manager. Training of employees shall include:  
1. Nature of the fall hazards employees may be exposed to.  
2. Correct procedures for erecting, maintaining, disassembling, and inspecting fall protection systems.

3. Use and operation of controlled access zones, guardrails, personal fall arrest systems, safety nets, warning lines, and safety monitoring systems.  
4. Role of each employee in the Safety Monitoring System (if one is used).  
5. Limitations of the use of mechanical equipment during roofing work on low-slope roofs (if applicable).  
6. Correct procedures for equipment and materials handling, and storage and erection of overhead protection.  
7. Role of each employee in alternative Fall Protection Plans (if used).  
8. Requirements of the OSHA Fall Protection Standard, 29 CFR 1926, Subpart M.  
9. Connecticut Water Company requirements for reporting incidents that cause injury to an employee.  
C. Additional training shall be provided on an annual basis, or as needed when changes are made to this Fall Protection Program, an alternative Fall Protection Plan, or the OSHA Fall Protection Standard.

**V. CONTROLLED ACCESS ZONES**  
A. Only authorized employees are permitted to enter controlled access zones and areas from which guardrails have been removed. All other workers are prohibited from entering controlled access zones.  
B. Controlled access zones shall be defined by control lines consisting of ropes, wires, tapes, or equivalent material, with supporting stanchions, and shall be:  
1. Flagged with a high-visibility material at six (6) foot intervals.  
2. Rigged and supported so that the line is between 30 and 50 inches (including sag) from the walking/working surface.  
3. Strong enough to sustain stress of at least 200 pounds.  
4. Extended along the entire length of an unprotected or leading edge.  
5. Parallel to the unprotected or leading edge.

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2. All nets shall be inspected at least once a week for wear, damage, or deterioration by a competent person. Defective nets shall be removed from use and replaced with acceptable nets.

3. All nets shall be in compliance with mesh, mesh crossing, border rope, and connection specifications as described in the OSHA Fall Protection Standard.

4. When nets are used on bridges, the potential fall area from the walking/working surface shall remain unobstructed.

5. Objects that have fallen into safety nets shall be removed as soon as possible and at least before the next working shift.

**G. Warning Line Systems**

Warning line systems consisting of supporting stanchions and ropes, wires, or chains shall be erected around all sides of roof work areas.

1. Lines shall be flagged at no more than six (6) foot intervals with high-visibility materials.

2. The lowest point of the line (including sag) shall be between 34 and 39 inches from the walking/working surface.

3. Stanchions of warning line systems shall be capable of resisting at least 160 pounds of force.

4. Ropes, wires, or chains must have a minimum tensile strength of 500 pounds.

5. Warning line systems shall be erected at least six (6) feet from the edge, except in areas where mechanical equipment is in use. When mechanical equipment is in use, warning line systems shall be erected at least six (6) feet from the parallel edge, and at least ten (10) feet from the perpendicular edge.

**VIH. TASKS AND WORK AREAS REQUIRING FALL PROTECTION**

Unless otherwise specified, a competent person shall evaluate the work(s) and determine the specific type(s) of fall protection to be used in the following situations.

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**A. Framework and Reinforcing Steel**

Fall protection will be provided when an employee is climbing or moving at a height of over 24 feet when working with rebar assemblies.

**B. Hoist Areas**

Guardrail systems or personal fall arrest systems will be used in hoist areas when an employee may fall four (4) feet or more. If guardrail systems must be removed for hoisting, employees are required to use personal fall arrest systems.

**C. Holes**

Covers or guardrail systems shall be erected around holes (including skylights) that are four (4) feet or more above lower levels. If covers or guardrail systems must be removed, employees are required to use personal fall arrest systems.

**D. Leading Edges**

Guardrail systems, safety net systems, or personal fall arrest systems shall be used when employees are constructing a leading edge that is four (4) feet or more above lower levels. An alternative Fall Protection Plan shall be used if a qualified person determines that the implementation of conventional fall protection systems is infeasible or creates a greater hazard to employees. All alternative Fall Protection Plans for leading edges shall:

1. be written specific to the particular jobsite needs;
2. include explanation of how conventional fall protection is infeasible or creates a greater hazard to employees;
3. explain what alternative fall protection will be used for each task;
4. be maintained in writing at the jobsite by a competent person; and
5. meet the requirements of 29 CFR 1926.502(k).

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1. capable of withstanding a force of at least 50 pounds; and

2. solid with a minimum of three and a half (3 1/2) inches tall and no more than one quarter (1/4) inch clearance above the walking/working surface.

G. Equipment shall not be piled higher than the toe board unless sufficient padding or screening has been erected above the toe board.

**X. ACCIDENT INVESTIGATIONS**

All incidents that result in injury to workers, as well as near misses, regardless of their nature, shall be reported and investigated. Investigations shall be conducted by the Program Manager as soon after an incident as possible to identify the cause and means of prevention to eliminate the risk of recurrence.

In the event of such an incident, the Fall Protection Program (and alternative Fall Protection Plans, if in place) shall be reevaluated by a qualified person to determine if additional practices, procedures, or training are necessary to prevent similar future incidents.

**XI. CHANGES TO THE PLAN**

Any changes to the Fall Protection Program (and alternative Fall Protection Plans, if in place) shall be approved by and shall be reviewed by a qualified person on the job progresses to determine additional practices, procedures or training needs necessary to prevent fall injuries. Affected employees shall be notified of all procedure changes, and trained if necessary. A copy of this plan, and any additional alternative Fall Protection Plans, shall be maintained at the jobsite by a competent person.

**XII. GLOSSARY**

**Anchorage:** a secure point of attachment for lifelines, layards, or deceleration devices.

**Authorized person:** means a person approved or assigned by the employer to perform a specific type of duty or duties or to be at a specific location or locations at the jobsite.

**Body belt:** a strap with means both for securing it about the waist and for attaching it to a lanyard, lifeline, or deceleration device.

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**Lifeline:** a component consisting of a flexible line for connection to an anchorage at one end and hung vertically (vertical lifeline), or for connection to anchorages at both ends to stretch horizontally (horizontal lifeline), that serves as a means for connecting other components of a personal fall arrest system to an anchorage.

**Low slope roof:** a roof having a slope less than or equal to 4 in 12 (vertical to horizontal).

**Opening:** a gap or void 30 inches (76 centimeters) or more high and 18 inches (46 centimeters) or more wide, in a wall or partition through which employees can fall to a lower level.

**Personal fall arrest system:** a system including but not limited to an anchorage, connectors, and a body harness used to arrest an employee in a fall from a working level.

**Positioning device system:** a body belt or body harness system rigged to allow an employee to be supported on an elevated vertical surface, such as a wall, and work with both hands free while leaning back.

**Qualified:** means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.

**Rope grab:** a deceleration device that travels on a lifeline and automatically, by friction, engages the lifeline and locks to arrest a fall.

**Safety monitoring system:** a safety system in which a competent person is responsible for recognizing and warning employees of fall hazards.

**Self-retracting lifeline/lanyard:** a deceleration device containing a drum-wound line which can be slowly extracted from, or retracted onto, the drum under minimal tension during normal employee movement and which, after onset of a fall, automatically locks the drum and arrests the fall.

**Snap hook:** a connector consisting of a hook-shaped member with a normally closed keeper, or a similar arrangement, which may be opened to permit the hook to receive an object and, when released automatically, closes to retain the object.

**Steep roof:** a roof having a slope greater than 4 in 12 (vertical to horizontal).

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the person in a manner that may be necessary to protect the person's health, safety, or property. This may include, but is not limited to, the thighs, pelvis, waist, chest, and arms.

**Competent person:** means one who is capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

**Connector:** A device that is used to couple (connect) parts of a personal fall arrest system or positioning device system together.

**Controlled access zone:** a work area designated and clearly marked in which certain types of work (such as overhead bricklaying) may take place without the use of conventional fall protection systems (guardrail, personal arrest, or safety net) to protect the employees working in the zone.

**Deceleration device:** any mechanism, such as a rope, grab, rip-stitch lanyard, specially-woven lanyard, tearing lanyard, deforming lanyard, or automatic self-retracting lifeline/lanyard, which serves to dissipate a substantial amount of energy during a fall arrest, or otherwise limits the energy imposed on an employee during fall arrest.

**Deceleration distance:** the additional vertical distance a falling person travels, excluding lifeline elongation and free fall distance, before stopping, from the point at which a deceleration device begins to operate.

**Guardrail system:** a barrier erected to prevent employees from falling to lower levels.

**Height:** a void or gap two (2) inches (5.1 centimeters) or more in the least dimension in a floor, roof, or other walking/working surface.

**Lanyard:** a flexible line of rope, wire rope, or strap that generally has a connector at each end for connecting the body belt or body harness to a deceleration device, lifeline, or anchorage.

**Leading edge:** the edge of a floor, roof, or formwork for a floor or other walking/working surface (such as a deck) which changes location as additional floor, roof, decking, or formwork sections are placed, formed, or constructed.

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**Toe board:** a low protective barrier that prevents material and equipment from falling to lower levels and which protects personnel from falling.

**Unprotected sides and edges:** any side or edge (except at entrances to points of access to a walking/working surface (e.g., floor, roof, ramp, or runway) where there is no wall or guardrail system at least 39 inches (1 meter) high.

**Walking/working surface:** any surface, whether horizontal or vertical, on which an employee walks or works, including but not limited to floors, roofs, ramps, bridges, runways, formwork, and concrete reinforcing steel. Does not include ladders, vehicles, or trailers on which employees must be located to perform their work duties.

**Warning line system:** a barrier erected on a roof to warn employees that they are approaching an unprotected roof side or edge and which designates an area in which roofing work may take place without the use of guardrail, body belt, or safety net systems to protect employees in the area.

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**XIII Attachment A Equipment**

Manufacturer: Miller by Sperian  
Franklin, PA  
Phone: 1-800-873-5242  
Phone: 1-814-432-2118

For complete list see the Safety Committee Chairman.

**Attachment B Trained Employees**

For complete list see the Safety Committee Chairman.

**Attachment C Facilities/Locations**

For complete list see the Safety Committee Chairman.

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**27.00 DISCIPLINE**

Employees committing unsafe acts\*, and supervisory personnel condoning such acts, may be subject to any of the following disciplinary actions, as warranted by the severity of the situation, as well as the employee's safety and disciplinary history:

1. A verbal warning;
2. A written warning;
3. A letter of reprimand;
4. A Last Chance Agreement;
5. Suspension without pay; and/or
6. Discharge from duties.

The use of discipline is never intended as punishment, but rather as a positive means of preventing further possible injury to employees or property.

Every employee must accept the responsibility of preventing accidents to himself/herself, to his/her fellow workers, and to the public, by cooperating in the enforcement of safety rules, employees and the public will be better protected and the operations of the Company made safe.

\*Unsafe acts are any acts which may result in injury to persons or property, and are not necessarily willful.

**BOATING**

- 26.00** Any person using or riding in a boat on Company business shall wear a Personal Flotation Device (PFD), Coast Guard Approved Type 3 or higher.
- 26.01** All boats shall have at least one set of oars or paddles.
- 26.02** A minimum of two people shall be in a Company boat.
- 26.03** Any employee operating a Company boat in the State of Connecticut must possess a valid State of Connecticut Safe Boating Certificate. The training and reimbursement of cost to obtain Certification shall follow established Company policies and procedures.
- 26.04** Employees shall follow prescribed procedures for trailering and launching boats.
- 26.05** All Company boats shall be State registered and have registrations displayed as required.
- 26.06** Care should be taken when refueling to avoid any spills.

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SECTION 332313 - GEOTHERMAL ENERGY EXCHANGE WELLS

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Geothermal loop heat exchangers / bores.
  - 2. Geothermal piping and accessories outside the building envelope.
  - 3. Casing pipe.
  - 4. Ball valves.
  - 5. Grout.
  - 6. Underground pipe markers.
  
- B. Related Sections:
  - 1. Division 3 – Site Clearing / Earthwork / Grading / Trenching
  - 2. Section 23 21 13 – Hydronic Piping.
  - 3. Section 23 05 23 - General-Duty Valves for HVAC Piping.
  - 4. Section 23 05 29 - Hangers and Supports for HVAC Piping and Equipment.
  - 5. Section 23 21 16 - Hydronic Piping Specialties.
  - 6. Section 23 81 46 – Water Source Unitary Heat Pumps

1.2 REFERENCES

- A. 49 CFR 192.285 - Plastic Pipe: Qualifying Persons to Make Joints; current edition.
- B. APHA (EWWW) - Standard Methods for the Examination of Water and Wastewater; 2012 (22nd Edition including all Errata).
- C. ASHRAE (HVACA) - ASHRAE Handbook - HVAC Applications; 2015.
- D. ASTM D2683 - Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing; 2014.
- E. ASTM D2837 - Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products; 2013.
- F. ASTM D3035 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter; 2015.
- G. ASTM D3261 - Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing; 2015.
- H. ASTM D3350 - Standard Specification for Polyethylene Plastics Pipe and Fittings Material; 2014.



- I. ASTM F714 - Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter; 2013.
  - J. ASTM F1055 - Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene and Crosslinked Polyethylene (PEX) Pipe and Tubing; 2016.
  - K. ASTM F1105 - Standard Practice for Preparing Aircraft Cleaning Compounds, Liquid-Type, Temperature-Sensitive, or Solvent-Based, for Storage Stability Testing; 2009 (Reapproved 2014).
  - L. EPA 712-C-02-190 - Health Effects Test Guidelines OPPTS 870.1100 Acute Oral Toxicity; 2002.
  - M. IGSHPA (GROUT) - Grouting Procedures for GHP Systems; International Ground Source Heat Pump Association; 1991.
  - N. IGSHPA (GVERT) - Grouting for Vertical GHP Systems; International Ground Source Heat Pump Association; 2000.
  - O. IGSHPA (INSTALL) - Closed-Loop/Geothermal Heat Pump Systems Design and Installation Standards; International Ground Source Heat Pump Association; 2009.
  - P. IGSHPA (SLINK) - Closed-Loop Geothermal Systems Slinky™ Installation Guide; International Ground Source Heat Pump Association; 1994.
  - Q. NFPA 704 - Standard System for the Identification of the Hazards of Materials for Emergency Response; 2017.
  - R. PPI TR-4 - PPI Listing of Hydrostatic Design Basis (HDB), Hydrostatic Design Stress (HDS), Strength Design Basis (SDB), Pressure Design Basis (PDB), and Minimum Required Strength (MRS) Ratings For Thermoplastic Piping Materials or Pipe; 2016.
  - S. USGS (FMWQ) - National Field Manual for the Collection of Water-Quality Data; United States Geological Survey; current edition.
- 1.3 ADMINISTRATIVE REQUIREMENTS
- A. Pre-installation Meeting: Convene two weeks before starting work of this section. Require attendance by all installers involved with site work and HVAC work.
- 1.4 SUBMITTALS
- A. Refer to Division 1 - Submittal Procedures General Requirements
  - B. Product Data, Polyethylene Vault and Piping: Provide manufacturer's data for vault, piping and pipe fittings, showing compliance with specified requirements.
    - 1. Provide manufacturer's recommendations for fusion jointing.
    - 2. Include certification of long term hydrostatic basis, or test reports.

- C. Product Data, Heat Exchange Fluid: Provide data showing compliance with specified requirements.
  - 1. Provide manufacturer's Material Data Safety Sheets.
  - 2. Include Provide results of biodegradability studies conducted in accordance with APHA (EWWW):
    - a. Statement of ecological behavior.
    - b. Total oxygen demand, in pounds (kg) of oxygen per pound (kg) of fluid.
    - c. Percent of fluid degraded in five days.
- D. Product Data, Grout and Slurry: Provide information on thermal conductivity of proposed materials.
- E. Shop Drawings: Show complete piping layout, vault, dimensioned location of each bore, water table, water level, depths of excavation, final depths of piping, backfill placement, point of entrance to building, point of connection to equipment, test point locations, and fittings used for all joints and connections.
- F. Soil and Rock Samples: Provide a sample for each different cutting material found on the site. Label which bore the material was found. .
- G. Test Reports, Soil: Indicate test methods and results for all tests performed on soil samples to determine stability, conductivity, and thermal values.
- H. Test Reports, Piping: Indicate test method and results of hydrostatic pressure tests.
- I. Record Documents: Record actual locations of all underground piping installed relative to Owner's permanent structure on same property.
- J. Operation and Maintenance Data: Provide procedures for pressurizing, charging, and isolation for equipment replacement.

#### 1.5 QUALITY ASSURANCE

- A. Designer Qualifications: Licensed Professional Engineer, regularly engaged in the design of systems of the type and capacity specified in this section, with not less than three years of documented experience, and accredited by IGSHPA.
- B. Installer Qualifications: Company specializing in performing the work of this section with minimum 5 years of documented experience and maintained accreditation by IGSHPA.
- C. Heat Fusion Technician Certification: IGSHPA training and certification, certified within three years from the date of project commencement.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Division 1 - Product Requirements for transporting, handling, storing, and protecting products.

- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials and water by temporary covers, completing sections of work, and isolating parts of completed system.

#### 1.7 COORDINATION

- A. Division 1 - Administrative Requirements
- B. Coordinate work with installation of geothermal heat pump system piping within building.

#### 1.8 WARRANTY

- A. Division 1 - Execution and Closeout Requirements.
- B. Furnish 50 year manufacturer's warranty for piping and fittings.

### PART 2 PRODUCTS

#### 2.1 GEOTHERMAL LOOP HEAT EXCHANGER SYSTEM

- A. Heat Exchanger Configuration: Closed system; polyethylene piping in vertical boreholes located adjacent to building, as indicated on drawings.
- B. Pipe: High density polyethylene pipe, type PE3408, PE3608, or PE4710, with minimum ASTM D3350 cell classification of PE345364C.
  - 1. Pipe Used in Vertical Bore Applications: Comply with ASTM D3035 with minimum working pressure rating of 160 psi.
  - 2. Other Pipe of 3 Inches Diameter and Larger: Comply with ASTM D3035 or ASTM F714, with minimum working pressure rating of 100 psi.
  - 3. Other Pipe Less Than 3 Inches In Diameter (Nominal): Comply with ASTM D3035 with minimum working pressure rating of 100 psi.
  - 4. Long Term Hydrostatic Design Basis: 1600 psi at 73 degrees F, when tested in accordance with ASTM D2837; appropriate listing in current edition of PPI TR-4 will constitute evidence of compliance with this requirement; otherwise, submit independent test results.
  - 5. Joints and Fittings: Polyethylene of same type as pipe, of sizes and types suitable for the pipe being used; use only heat fusion or stab-type mechanical fittings that are quality controlled to provide a leak-free union between piping ends that is stronger than the piping itself. Do not use other barbed fittings or hose clamps.
    - a. Electrofusion Type Fittings: Comply with ASTM F1055.
    - b. Butt Fusion Fittings: Comply with ASTM D3261
  - 6. Product shall be listed in PPI TR-4 2017 or after for the material to be used.
  - 7. All piping shall regardless of diameter and rating should not submitted to exceed 1.7 feet per 100 foot of pressure drop at 2.28 feet per second velocity.



8. Polyethylene Pipe Materials: For connections to equipment and valves with threaded connections, furnish fused transition with reinforced threads. Do not use barbed type fittings.
  9. U-Bend: Provide closure for each vertical geothermal loop heat exchanger using single or double-elbow style U-bend at bottom of loop. Construct U-bend attached to geothermal loop heat exchanger using heat fusion bonding method. No other fusion joints are permitted on vertical heat exchanger piping below level of manifold piping.
- D. U-Bend: Provide closure for each vertical geothermal loop heat exchanger using single elbow style U-bend at bottom of loop. The polyethylene u-bend assembly shall be manufactured from a polyethylene extrusion grade material having a minimum cell classification of PE345434C per ASTM D-3350 and shall fully comply with the ISGHPA standard 1C "Ground Heat Exchanger Materials" and factory assembled to the geothermal loop heat exchanger using heat fusion bonding method and pressure tested to 100psi. No other fusion joints other than the U-bend are permitted on vertical heat exchanger piping below level of manifold piping. All Piping used for the U-bend heat exchanger shall be factory hot stamped lengths impressed on the side of the piping indicating the length of the heat exchanger. The length shall read zero at the u-bend and the actual heat exchanger total length on the other end. Pressure test U-bend and associated tubing to 100 psi prior to insertion into the vertical bore.

## 2.2 BALL VALVES

- A. Manufacturers:
1. Crane Valve
  2. NIBCO, Inc. Model T 585-70.
  3. Apollo Valves Model 77F-100 Series
- B. 3 inches and Smaller: MSS SP 110, 400 psi WOG, one piece bronze body, chrome plated brass ball, full port, teflon seats, blow-out proof stem, threaded ends, lever handle.

## 2.3 CASING PIPE

- A. Steel Pipe: ASTM A53/A53M, Grade B, with minimum wall thickness of 0.280 inches, with outside diameter of 5-1/2 inches.
- B. Length to accommodate site conditions.

## 2.4 GROUT

- A. Mixture of bentonite clay with clean water to facilitate well placement.
- B. Maximum permeability rate of less than  $1.2 \times 10^{-8}$  ml/s in fresh water as determined by using "Falling-Head Method" defined in United States Army Corps of Engineers' Civil Engineering Manual No. EM1110-2-1906, "Laboratory Soils Testing" and as recommended by U.S. Environmental Protection Agency to ensure proper sealing.
- C. Minimum mixture of 15 percent to 20 percent solids.

2.5 WATER SUPPLY

- A. Furnish supply of potable water to perform the Work.
- B. Furnish equipment including pumps, water trucks or trailers, storage tanks and other items necessary to supply adequate supply of potable water.

2.6 UNDERGROUND PIPE MARKERS

- A. Provide Detectable Underground Tape: Magnetic detectable conductor in 3” wide 5 mills thick rot resistant plastic tape or mesh, brightly colored, imprinted with “BURIED GEOTHERMAL LINE BELOW” in large letters .

PART 3 EXECUTION

3.2 EXAMINATION AND PREPARATION

- A. Prior to arrival on-site, clean and repair drilling rig, drill rods, tools and bits removing potential sources of contamination, including leaks, excessive grease, oils, gasoline or other substances.
- B. Notify utility companies to mark location of existing underground services. Do not begin work of this section until existing underground services are marked.
- C. Verify location of existing structures and utilities prior to excavation. Notify building occupants and adjacent land owners with 14 days notice before proceeding with the work.
- D. Verify soil composition and rock depth, if any, before beginning excavation.
- E. Protect underground utilities and adjacent structures from the effects of excavation.
- F. Verify the layout dimensions are correct and that available land is sufficient for design.
- G. Notify Architect of unsatisfactory conditions.
- H. Do not proceed with installation until unsatisfactory conditions have been corrected.
- I. Coordinate work with site grading, site backfilling, and foundation construction.
- J. Provide barricades, shields or temporary wall structures to protect adjacent structures, parking lots, roadways, vehicles, and pedestrians, from water or debris thrown from drilling or excavating process.
- K. Direct engine exhaust fumes away from occupied areas adjacent to work area.
- L. Confined work areas: direct engine exhaust fumes to atmosphere with closed, sealed exhaust system.

### 3.3 EXCAVATION

- A. Excavate in accordance with requirements of authorities having jurisdiction.
- B. Vertical Boreholes: Drill to depths required.
  - 1. Minimize over-drilling; fill over-drilled areas with backfill or excavated materials.
  - 2. Piping: Assemble heat exchanger piping and test before installation.
- C. Trenches: Excavate trenches for piping to lines and grades shown on drawings.
  - 1. Minimize over-excavation; fill over-excavated areas with backfill or excavated materials.
  - 2. Excavate to accommodate grade changes.
  - 4. Maintain trenches free of debris, material, and obstructions that may damage pipe.
  - 5. Piping: Assemble heat exchanger piping and test before backfilling.

### 3.4 DRILLING

- A. Perform drilling in accordance with IGSHPA Installation Guide.
- B. Bore vertical holes clean with no permanent casing and of sufficient diameter to facilitate installation of U-tube assembly.
- C. Do not introduce drilling fluids other than bentonite slurry into boring.
- D. Ensure bore does not contain large, sharp or jagged rocks or debris.
- E. Drill, clean, and purge bore holes to depth as indicated on Drawings.
- F. Do not use drill cuttings as part of borehole construction.
- G. Dispose of drilling waste and water in accordance Local, State and Federal laws and regulations.
- H. When required, install temporary casing to keep upper consolidated materials from caving into boring. Install length to accommodate site conditions. Remove temporary casing immediately upon completion of grouting of borehole.
- I. Throughout drilling process take precautions to keep material considered contaminant from entering boreholes. When borehole becomes contaminated perform necessary work to eliminate contamination.

3.5 INSTALLATION VERTICAL GEOTHERMAL LOOP HEAT EXCHANGER PIPING

- A. Join piping and fittings using heat fusion or electrofusion; do not use solvents, adhesives, or mechanical fittings. .Remove dirt from inside of piping before assembly.
- B. Provide flanges or unions to connect heat exchanger piping to equipment or piping of different type; locate all transitions between piping of different types inside the building or otherwise accessible (i.e. above grade).
- C. Keep dirt, water, and debris out of pipe assemblies; cap or plug open ends until connected to adjacent piping.
- D. Do not bend piping to shorter radius than recommended by pipe manufacturer; do not kink piping; use elbow or other fittings for sharp bends.
- E. Partially backfill radius bends in narrow trenches by hand to ensure that piping is properly supported and to prevent kinking.
- F. Test piping to be installed in boreholes after assembly but before installation in boreholes; re-cap tested assemblies before installation.
- G. Test piping to be installed in trenches after installation but before backfilling.
- H. Testing: Perform hydrostatic test on all piping; portions of assembled piping may be tested separately.
  - 1. Prior to testing, isolate piping from all connections to building systems.
  - 2. Flush all dirt and debris using potable water flowing at twice the normal operating flow rate for a minimum of four hours or until no dirt or debris is visible, whichever is longer.
  - 3. Plug or cap piping.
  - 4. Pressurize piping to 150 psi for 2 hours and monitor.
  - 5. If there is any pressure loss or visible leakage, identify leak and repair in accordance with manufacturer's recommendations.
  - 6. Repeat test until there is no loss of pressure for the duration of the test.
- I. Insulation: Insulate the following heat exchanger piping:
  - 1. Above ground piping.
  - 2. Below ground but within 36 inches of ground surface.
  - 3. Below ground running parallel with and within 5 feet of walls, structures, or water pipes.
  - 4. Indoor piping that will be colder than ambient air temperature.

- J. Where piping passes through foundation walls, provide sleeves sealed with non-hardening, waterproof material.
  - K. After connection of piping to building systems and installation of equipment served by heat exchanger, fill piping with heat exchange fluid and pressurize.
- 3.6 GROUTING
- A. Completely grout each vertical geothermal loop heat exchanger borehole with bentonite clay grout in accordance with IGSHPA Grouting Procedures for Ground-Source Heat Pump Systems.
    - 1. Monitor each bore hole for settling of grouting material after initial grouting, and continue adding grout to maintain level.
    - 2. Pressure pump grout material through 1 inch or 1-1/2 inch inside diameter tremie pipe placed in bore column from bottom to top to ensure complete fill of bore column.
- 3.7 BACKFILLING
- A. Install in compliance with local authorities having jurisdiction.
  - B. Vertical Boreholes: Backfill after pipe installation in accordance with IGSHPA (GROUT) - IGSHPA Grouting Procedures for GHP Systems.
  - C. Boreholes: Fill annular space around pipe with water-bentonite slurry.
  - D. Trenches:
    - 1. Provide minimum 40 inch cover over piping.
    - 2. Backfill trenches after pipe has been installed and tested, using fill free of rocks and other debris.
    - 3. Install detectable tape continuously 6 inches (150 mm) above top of all buried pipe.
    - 4. Backfill and compact using the procedures specified in Section 31 2316.13.
    - 5. Backfill to original grades with sufficient overfill to allow for settlement.
- 3.8 CLEANING
- A. Leave adjacent paved areas broom clean.
  - B. Clear debris, including excess backfill and excavated dirt and rock, from heat exchanger area.
- 3.9 CLEANING, FLUSHING, AIR PURGING AND WATER TREATMENT
- A. Upon completion of all work, all piping systems shall be flushed with water or liquid alkaline solution with emulsifying agents and detergents, to remove dirt, grease, grit, chips and foreign matter.
  - B. Solution for flushing shall be used in sufficient quantity to produce a velocity of at least 2.5 feet per second. Flushing shall continue until discharge solution shows no discoloration or evidence of foreign materials.

- C. During flushing operation, all valves shall be operated several times, bypasses opened, pumps operated and equipment flushed.
  - D. Upon completion of flushing operations, all strainers, filters and blowdowns shall be removed and cleaned of accumulated waste.
  - E. Systems with propylene glycol solutions: Upon completion of flushing and testing, all piping and equipment shall be drained to ensure a proper propylene glycol/water mixture. Blow out piping and equipment with air as required to remove all water from system.
  - F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00.
  - G. Purge air from system.
  - H. Geothermal Energy Exchange Wells Contractor (Spec Section 332313) and “Building Contractor” (Spec Section 232112) shall be both responsible for the entire combined system including all piping on site, piping in bores and piping at interior of the building (all piping at the load side of the heat pumps to and including the bore fields). Both contractors shall be responsible for cleaning, flushing, air purging and water treatment of the entire system.
- 3.10 PROTECTION OF FINISHED WORK
- A. Protect area during excavation from excess runoff and erosion.
  - B. Protect pipe protrusion from damage until connection to building systems are installed.

END OF SECTION 332313

## SECTION 333000 – EXTERIOR SANITARY SEWER UTILITIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. The underground sanitary sewer system begins at 5' beyond outside of buildings complete, ready for operation, including all gravity flow lines; pressure (force) lines; manholes; cleanouts; appurtenances; connections to new building and structure, service lines, required special fittings and restrains to the new pipes, installed by Directional Drilling, and existing water service lines, and all other incidentals existing sanitary sewer lines, and existing sanitary structures; and all other incidentals.
- B. Coordination with The Town Of Thomaston WPCA.
- C. The Contractor's responsibility includes furnishing, installing, monitoring, and maintaining Erosion and Sedimentation devices, as required by the Construction Documents. After the required work is completed and accepted, it is the Contractor's responsibility to remove the Erosion and Sedimentation devices and dispose of the Site.
- D. The Contractor's responsibility includes clearing and grubbing work areas, cutting and patching the bituminous pavement, disposing of the debris of the Site, restriping pavement, repairing gravel surfaces, protecting, dismantling, and reinstalling the wooden fence, Jersey barrier, and any other obstruction, and topsoiling and seeding disturbed lawn on the Black Rock State Park, the CT DEEP Maintenance garage property, 422 Watertown Road, and with CT DOT R.O.W, and Route 6. See the Project specifications, plans, and details for the restoration information.
  - 1.
  - 2. The Contractor's responsibility includes patching the bituminous pavement, gravel surface, and topsoiling and seeding disturbed lawn on the CT DEEP Maintenance garage property, 422 Watertown Road, and with CT DOT R.O.W, and Route 6. See the Project documents and details for the restoration information.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. Town of Thomaston WPCA Rules and Regulations.

- C. Connecticut Public Health Code Rules and Regulations.
- D. State of Connecticut Department of Transportation "The Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, as amended and merged with the July 2019 supplemental specifications.
- E. The Project is subject to General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities. Part of the General Permit, Stormwater Pollution Control Plan (SWPCP) is prepared and approved by CT DEEP for the Contractor to use.

### 1.3 RELATED SECTIONS

- A. Division 3, Concrete Specifications for the concrete.
- B. Section 220500 "Common Work Results for Plumbing" for General Plumbing, Protection of Materials and Equipment, and Quality Assurance
- C. Section 312000 "Earthmoving".
- D. Section 312319 "Dewatering".
- E. Section 312333 "Trenching and Backfilling" for Excavation, Detectable Warning Tape, and Backfill.
- F. Section 312513 "Erosion Controls".
- G. Section 315000 "Excavation Support and Protection" for Shoring, Sheeting, and Bracing.
- H. Section 321216 "Asphalt Paving".
- I. Section 321313 "Concrete Paving".
- J. Section 321613 "Precast Concrete Curbing".
- K. Section 321723 "Pavement Markings".
- L. Section 329200 "Turf and Grasses".
- M. Section 333200 "Sanitary Sewage Pump Station".



- N. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

#### 1.4 GENERAL REQUIREMENTS

- A. Install, monitor, and maintain all erosion and sedimentation devices prior to any site or work area disturbance. That includes but not limited: siltation fence, silt socks, construction entrances, haybales, and silt boom.
- B. Remove and safely store the wooden fence, jersey barrier, and any other obstruction.
- C. Cut bituminous concrete pavement and curbing, and dispose of the Site.
- D. Clear and grub work area and dispose of the debris of the Site.

#### 1.5 ABBREVIATIONS

- A. PVC: Polyvinyl chloride plastic.
- B. HDPE: High-Density polyethylene.
- C. Thomaston WPCA: Thomaston Water Pollution Control Authority.

#### 1.6 SUBMITTALS

- A. Product Data: For the following:
  - 1. PVC – Sewer Pipe and Fittings.
  - 2. PE -HDPE – Sewer Pipe.
  - 3. Expansion joints and deflection fittings.
  - 4. Backwater valves, if applicable.
- B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
  - 1. Include construction details, material descriptions, dimensions of individual components, and profiles.
  - 2. Include manholes, manhole openings, covers, cleanouts, cleanout covers, pipes, and joints, couplings, and sleeves connections.
- C. Coordination Drawings, if required: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in the same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.

- D. Coordination Profile Drawings if required: Show system piping in elevation. Draw profiles at a horizontal scale of not less than 1 inch equal 50 feet (1:500) and vertical scale of not less than 1 inch equals 5 feet (1:50). Indicate underground structures and pipes. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- E. Shop drawings and calculations all specials fittings, joint restraint systems, adapters, and couplings that require connect PVC SCH. 40, PVC SCH.80, and SDR 35 pipes to HDPE.
- F. Product Certificates: For each type of cast-iron soil pipe and fitting, from the manufacturer.
- G. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

#### 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipes, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle precast concrete manholes and other structures according to manufacturer's written rigging instructions.

#### 1.8 PROJECT CONDITIONS

- A. Call "CALL BEFORE YOU DIG (1-800-922-4455) or other service providers 72 hours prior to any excavation.
- B. Site Information: Perform site survey, research public utility records, and verify existing utility locations on-site prior construction.
- C. Locate existing structures and piping, remove as indicated on the demolition drawing or to be closed and abandoned in-place.
- D. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Construction Manager and/or Owner not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Construction Manager and/or Owner's written permission.

## 1.9 QUALITY ASSURANCE

- A. Comply with all rules and regulations of the Public Utility (Thomaston Water Pollution Control Authority) having jurisdiction over the connection to public sanitary sewer lines and the extension, and/or modifications to Public Utility systems.
- B. Comply with all rules and regulations of Federal, State, and Local Health Department, Department of Energy and Environmental Protection having jurisdiction over the design, construction, and operation of sanitary sewer systems.
- C. Qualifications.
  - 1. Install sanitary sewer force main that is watertight both in pipe-to-pipe joints and in pipe-to-manhole connections.
  - 2. Perform testing in accordance with Acceptance Testing for Sanitary Sewers in Part 3 of this Section.
- D. Regulatory Requirements.
  - 1. Install pressurized sewer lines to meet minimum State-mandated separation distance from potable water lines. The separation distance is defined as the distance between the outside of the water pipe and outside of the sewer pipe. Install new sanitary sewers no closer to water lines than ten feet in all horizontal directions. Where water and pressurized sanitary sewer lines cross, a minimum vertical separation in accordance with state and/or local standards is required when the water line passes above or below the sanitary sewer main. Where separation distance cannot be achieved, sanitary sewers pipes shall be sleeved (as detailed on the Drawings) for a minimum distance of ten feet either side of the crossing.

## PART 2 - MATERIALS AND PRODUCTS

### 2.1 SANITARY SEWER PIPING

- A. Gravity Sewer Pipe and Fittings
  - 1. Comply with the requirements of the Thomaston Water Pollution Control Authority.
  - 2. For distribution pipes and fittings where indicated on drawings and details: PVC SDR 35, ASTM D 3034. Rubber compression gasket couplings, ASTM D 3139 or equal. Or solvent weld couplings/fittings using proper two-step PVC solvent solution procedure.
  - 3. For distribution pipes and fittings where indicated on drawings and details: PVC SCH.40, ASTM D 1785 or ASTM D 2665. Rubber compression gasket

couplings, ASTM D 3139 or equal. Or solvent weld couplings/fittings using proper two-step PVC solvent solution procedure.

- B. Pipe and Fittings: ASTM D 2729, perforated, for solvent-cemented joints.
- C. Solvent Cement: ASTM D 2564. Include primer according to ASTM F 656.
- D. Pressure Sewer Pipe and Fittings
  1. PVC pressure water pipe AWWA C900 (PC 200 psi minimum). Acceptable joints are bell and spigot with compression rubber gaskets.
  2. PVC ASTM D 1785 / ASTM D 2665, Schedule 40 or Schedule 80. Acceptable joints are Solvent welded, threaded joints or gasketed couplings.
  3. Polyethylene plastic flexible pressure pipe ASTM D 2239 or ASTM D 2737. No joints within 75 ft. of well or 25 ft. of an open watercourse, ground or surface water drains. Heat butt fused connections. Pipe available in 100-ft. and longer coiled lengths.
  4. Pipe and Fittings: ASTM D 2729, for solvent-cemented joints.
- E. Mechanical joint anchor fittings shall be used to transition from HDPE to PVC. The fitting shall be stronger than the pipe in that when it is subjected to tensile stress, the pipe will pull apart before the fitting will pull out and the pipe blow before the fitting will rupture under pressure.
- F. The mechanical joint Adapter shall have a pre-installed stainless-steel stiffener, in accordance with Plastic Pipe Institute (PPI) recommendations, to neutralize point-loading, ACQ, creep and loss of gasket seal due to diameter contraction. The stiffener shall be engineered sufficiently thick to avoid radial buckling due to gasket pressure.
- G. The Mechanical Joint Adapter requires longer bolts and shall be sold with the modified longer bolt kit to avoid construction delays or improper installation with too shorth bolts.
- H. All fittings for forcemain or pressure rated fittings shall be rated according to the manufacturer's written specifications, and clearly labeled on the fitting as such.
- I. Installation: The installation shall conform to the requirements of the manufacturer, the AWWA Standard, and as indicated on the plans and specified herein.
- J. Marking and Certification: Each length of HDPE sanitary sewer shall be clearly marked with the Manufacturer's Name, Tradename or Trademark, Nominal pipe size, Pipe Stiffness, Production Code/Extrusion Code, Material Cell Class Designation and ASTM number.
- K. The pipe manufacturer shall provide certification that the stress regression testing has been performed on the specific product. The said certification shall include a stress live curve per ASTM D-2837. The stress regression testing shall have been performed in accordance with ASTM D-2837, and the manufacturer shall provide a product supplying a minimum Hydrostatic Design Basis of 1,600 psi as determined by ASTM D-2837. This certification

shall also state that the pipe was manufactured from one specific resin in compliance with these specifications. The certificate shall state the specific resin used and its source.

## 2.2 NONPRESSURE PIPE COUPLINGS

- A. Description: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of the same sizes as piping to be joined, with corrosion-resistant-metal tension band and tightening mechanism on each end.
  - 1. Sleeve Materials for Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  - 2. Sleeve Materials for Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
  
- B. PVC Schedule 40, ASTM D1785 or ASTM D2665.
  - 1. Rubber compression gasket couplings, ASTM D3139.
  - 2. Solvent weld couplings and fittings using the proper two-step PVC solvent solution procedure.
  - 3. Use of 3 inches wide approved stainless steel banded couplings on PVC, ASTM D1785 or 2665 is acceptable.
  - 4. UL (gray) Piping – Schedule 40 – 36” min. radius sweep piping (90°) may be utilized without a cleanout.
  - 5. ABS Schedule 40 is not acceptable.

## 2.3 SANITARY SEWER STRUCTURES

- A. Sanitary Sewer Manholes
  - 1. Normal-Traffic HS-20, Pre-cast Concrete Manholes: ASTM C 478, pre-cast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints conforming to the requirements of Section 5.07 of the State of Connecticut Department of Transportation “Standard Specifications for Road, Bridge and Incidental Construction”, Form 817 as amended and including the current July 2019 supplemental specifications and the Thomaston Water Pollution Control Authority (TWPCA) standard details and specifications.
    - a. Diameter: 48 inches minimum, unless otherwise indicated.
    - b. Ballast: Increase the thickness of pre-cast concrete sections or add concrete to the base section, as required to prevent flotation.
    - c. Base Section: 6-inch minimum thickness for floor slab and 5-inch minimum thickness for walls and base riser section and having a separate base slab or base section with an integral floor.
    - d. Riser Sections: 8-inch minimum thickness, and lengths to provide depth indicated.

- e. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of a cone of the size that matches grade rings.
- f. Gaskets: ASTM C 443, rubber.
- g. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match 24-inch diameter frame and cover.
- h. Steps: Copolymer Polypropylene plastic steel-reinforced, as indicated. Cast or anchor into the base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
- i. Pipe Connectors: ASTM C 923, resilient, of the size required, for each pipe connecting to the base section.
- j. Manholes must have watertight joints.
- k. Manholes must have an exterior coating with BayOil "Ebony".
- l. Manhole Frames and Covers: ASTM A 48 class 35B gray cast iron with no asphalt coating, AASHTO HS 20 load rated. Include 24-inch ID by 7- to 9-inch riser with 4-inch minimum width flange, and 26-inch diameter cover. Include "TWPCA" logo design with 1" square face pattern 1/8" high, see detail.

B. Sanitary Sewage Pump Station

- 1. See Division 33, Section 333200.

C. Sanitary Sewer Cleanouts

- 1. PVC Cleanouts:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provided on the drawings.
  - b. Description: PVC body with PVC threaded plug. Include PVC sewer pipe fitting and riser as shown in the detail. Provide gray, cast - iron frame and cover as shown in the details.
  - c. Top-Loading Classification(s): Heavy Duty or as noted on the drawings.
  - d. PVC SCH.40 6 inch as defined by drawings and details.

## 2.4 BEDDING AND BACKFILL MATERIAL

- A. Comply with the requirements of the Thomaston Water Pollution Control Authority.
- B. Bedding and initial backfill shall be ¾" crushed stone conforming to the requirements of Section M.01. for No.6 stone of the State of Connecticut Department of Transportation "Standard Specifications for Roads, Bridges, and Incidental Construction", Form 817, including July 2019 supplemental.
- C. Final backfill material shall be bank-run gravel conforming to the Requirements of Section M.02.01-2 of the State of Connecticut Department of Transportation "Standard Specifications

for Roads, Bridges and Incidental Construction”, Form 817, including July 2019 supplemental in paved areas, including sidewalks and driveways, and common fill in non-paved areas. Material shall be thoroughly compacted in 6” lifts.

## 2.5 GEOTEXTILE FABRIC

- A. Comply with the requirements of the Thomaston Pollution Control Authority.
- B. Geotextile Fabric: Mirafi 140N or SUPAC 5NP or approved equal non-woven filter fabric.

## 2.6 CONCRETE

- A. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
  - 1. Cement: ASTM C 150, Type II.
  - 2. Fine Aggregate: ASTM C 33, sand.
  - 3. Coarse Aggregate: ASTM C 33, crushed gravel.
  - 4. Water: Potable.
- B. Portland Cement Design Mix: 4,500 psi minimum, with 0.45 maximum water-cementitious materials ratio.
  - 1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
  - 2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.
- C. Structure Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4,500 psi minimum, with 0.45 maximum water-cementitious materials ratio. Include channels and benches in manholes.
  - 1. Channels: Concrete invert, formed to the same width as connected piping, with a height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
    - a. Invert Slope: 1 percent through the manhole.
  - 2. Benches: Concrete, sloped to drain into the channel.
    - a. Slope: 4 percent.

## 2.7 PROTECTIVE COATINGS

- A. Comply with the requirements of the Thomaston Water Pollution Control Authority.
- B. Description: One- or two-coat, coal-tar epoxy; 15-mil minimum thickness, unless otherwise indicated; factory or field applied to the following surfaces:
  - 1. Concrete Manholes: On the exterior surface.

2. Manhole Frames and Covers: On surfaces that will be exposed to sewer gases.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Refer to Division 31, Section 312333 "Trenching and Backfilling" for excavating, trenching, and backfilling.

#### 3.2 IDENTIFICATION

- A. Materials and their installation are specified in Division 31, Section 312333 "Trenching and Backfilling." Arrange for installing green warning tapes directly over piping and at outside edges of underground structures.
  1. Use detectable warning tape over nonferrous piping and over edges of underground structures.
  2. Green with black letters and imprinted with "CAUTION BURIED SEWER LINE BELOW".

#### 3.3 PIPING APPLICATIONS

- A. Comply with the requirements of the Thomaston Water Pollution Control Authority.
- B. General: Include watertight joints.
- C. Refer to Part 2 of this Section for detailed specifications for pipe and fitting products listed below. Use pipe, fittings, and joining methods according to applications indicated.
- D. Gravity-Flow Piping: Use the following:
  1. NPS 8 and NPS 10: PVC sewer pipe and fittings, solvent-cemented joints, or gaskets and gasketed joints.

#### 3.4 SPECIAL PIPE COUPLING AND FITTING APPLICATIONS

- A. Comply with the requirements of the Thomaston Water Pollution Control Authority.



- B. Special Pipe Couplings: Use where required to join piping and no other appropriate method is specified. Do not use instead of specified joining methods.
  - 1. Use the following pipe couplings for non-pressure applications:
    - a. Sleeve type to join piping, of the same size, or with a small difference in OD.
    - b. Increaser/reducer-pattern, sleeve type to join piping of different sizes.
    - c. Bushing type to join piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.
  
- C. Special Pipe Fittings: Use where indicated. Include PE film, pipe encasement.

### 3.5 INSTALLATION

- A. Comply with the requirements of the Thomaston Water Pollution Control Authority.
  
- B. General Locations and Arrangements: Drawing plans and details indicate the general location and arrangement of underground sanitary sewerage piping. The location and arrangement of the piping layout take design considerations into account. Install piping as indicated, to the extent practical.
  
- C. Install piping beginning at a low point, true to grades and alignment indicated with an unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cement, and other installation requirements. Maintain swab or drag in line, and pull past each joint as it is completed.
  
- D. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into the existing sewer is indicated.
  
- E. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing the size of piping in the direction of flow is prohibited.
  - 1. Install gravity-flow piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.
  
- F. Extend sanitary sewerage piping and connect to building's sanitary drains, of sizes and in locations indicated. Terminate piping as indicated.

### 3.6 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. Comply with the requirements of the Thomaston Water Pollution Control Authority.
- B. General: Join and install pipe and fittings according to installations indicated.
- C. PVC Sewer Pipe and Fittings: As follows:
  - 1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
  - 2. Join profile sewer pipe fittings with gaskets according to ASTM D 2321 and manufacturer's written instructions.
  - 3. Install according to ASTM D 2321.
- D. System Piping Joints: Make joints using system manufacturer's couplings, unless otherwise indicated.
- E. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.
- F. Install with top surfaces of components, except piping, flush with a finished surface.

### 3.7 MANHOLE INSTALLATION

- A. Comply with the requirements of the Thomaston Water Pollution Control Authority.  
General: Install manholes, complete with appurtenances and accessories indicated.
- B. Form continuous concrete channels and benches between inlets and outlets.
- C. Set tops of frames and covers flush with the finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.
- D. Install precast concrete manhole sections with gaskets according to ASTM C 891.

### 3.8 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

### 3.9 CLOSING ABANDONED SANITARY SEWERAGE SYSTEMS

- A. Abandoned Piping and Structures according to the latest requirements of the Thomaston Water Pollution Control Authority
- B. Abandoned Structures: Excavate around structure as required. Void to be backfill and compacted to grade according to Division 31 Section "Earth Moving."

### 3.10 FIELD QUALITY CONTROL

- A. Comply with the requirements of the Thomaston Water Pollution Control Authority.
- B. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed.
  - 1. Place plug-in the end of incomplete piping at end of day and when work stops.
  - 2. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.
- C. Inspect the interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at the completion of the Project.
  - 1. Submit separate reports for each system inspection.
  - 2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of the inside of the pipe is visible between structures.
    - b. Deflection: Flexible piping with a deflection that prevents the passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  - 3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  - 4. Re-inspect and repeat the procedure until the results are satisfactory.
- D. Test new piping systems, and parts of existing systems that have been altered, extended or repaired, for leaks and defects.
  - 1. Do not enclose, cover, or put into service before inspection and approval.

2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate reports for each test.
5. If authorities having jurisdiction do not have published procedures, perform tests as follows:
  - a. Sanitary Sewerage: Perform the hydrostatic test.
    - 1) Allowable leakage is a maximum of 50 gal. per inch of nominal pipe size per mile of pipe, during 24-hour period.
    - 2) Close openings in the system and fill with water.
    - 3) Purge air and refill with water.
    - 4) Disconnect water supply.
    - 5) Test and inspect joints for leaks.
    - 6) Option: Test ductile-iron piping according to AWWA C600, Section "Hydrostatic Testing." Use test pressure of at least 10 psig.
  - b. Sanitary Sewerage: Perform an air test according to UNI-B-6.
    - 1) Option: Test concrete piping according to ASTM C 924 (ASTM C 924M).
6. Manholes: Perform a hydraulic test according to ASTM C 969 (ASTM C 969M).
7. Leaks and loss in test pressure constitute defects that must be repaired.
8. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

### 3.11 CLEANING

- A. Clean dirt and superfluous material from the interior of piping. Flush with potable water.

### 3.12 CLOSEOUT ACTIVITIES

- A. Immediately upon completion of work, remove all rubbish and debris from the job site. Remove all construction equipment and implements of service, leaving the entire area involved in a neat condition acceptable to the Architect and/or Construction Project Manager.
- B. Reinstall the wooden fence, jersey barrier, and any other items that were removed and store that relates to this part of the construction.
- C. Patch bituminous concrete pavement and curbing, and restore striping.
- D. Repair any gravel area if it was disturbed during the construction or from contraction equipment or activities.

- E. Provide topsoil and seed the disturbed areas.
- F. Remove all erosion and sedimentation devices when ground cover is established and dispose of the Site.

### 3.13 AS-BUILT

- A. Final As-built of all underground structures and pipes location and elevations to be prepared by a CT Licensed surveyor in a paper, Mylar and AutoCad format, signed and sealed accuracy class A-2/T-2, and submitted to the Town of Thomaston WPCA and Property Owner.

END OF SECTION 333000

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SECTION 333200 SANITARY SEWAGE PUMP STATION

PART 1 - GENERAL

1.1 SUMMARY

- A. The pump station and all equipment contained within shall be furnished as a complete **Factory Fabricated Packaged System. Field Erected Pump Stations Will Not Be Allowed.**
- B. It the Contractor's responsibility and expense to check, confirm, and modify the design (plans, profiles, sections, details, and specifications) provided to accommodate the selected Manufacturer's prefabricated packaged system. The Contractor shall provide field subgrade investigation if he/she believes needed to install the pump station, designing/planning, calculations, equipment, labor, all other incidentals, and etc. necessary to complete the pump station in place, as indicated on drawings. The pump station components and materials shall match those indicated on the plans. The Fabricated Packaged Pump station system construction plans, sections, details, and specifications that prepared by the Contractor shall be stamped and sealed by Profesional Engineer registered in the State of Connecticut and submitted to the design engineer as a shop drawings for review and approval.
- C. The Contractor shall furnish & install the 8,300 Gallon Sanitary Sewage Pump Station complete with all equipment as indicated on the drawings and specified herein as required for a complete, properly operating pumping station.
- D. The Contractor shall fully coordinate all related field operations with the pump station supplier. Coordination shall include: verifying dimensions of equipment furnished; interfacing with and connection of all exterior piping and utilities in the field; connecting external power to the pump station wet well as required; and all other miscellaneous operations.
- E. It is the Contractor's responsibility and expense to provide the pump station chamber with anti-buoyancy/floatation provisions, including calculations prepared and certified by a Profesional Engineer register in the State of Connecticut.
- F. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

## 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. State of Connecticut Department of Transportation "The Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, as amended and merged with the July 2019 supplemental specifications.
- C. Thomaston Water Pollution Control Authority rules and regulations.
- D. Connecticut Public Health Code Rules and Regulations.
- E. The Project is subject to General Permit for the Discharge of Stormwater and Dewatering Wastewaters from Construction Activities. Part of the General Permit, Stormwater Pollution Control Plan (SWPCP) is prepared and approved by CT DEEP for the Contractor to use.

## 1.3 RELATED SECTIONS

- A. Division 26, Electrical.
- B. Division 27, Communications.
- C. Section 312000 "Earthmoving"
- D. Section 312333 "Trenching and Backfilling" for Excavation, Detectable Warning Tape, and Backfill.
- E. Section 312319 "Dewatering".
- F. Section 315000 "Excavation Support and Protection".
- G. Section 333000 "Exterior Sanitary Sewer Utilities".

## 1.4 SUBMITTALS

- A. The Contractor shall provide the following information for review:
  - 1. Shop drawings for the precast concrete pump station structures, pumps, piping, electrical and mechanical component, including alarm, and valves complete with supporting calculations that have been prepared and certified by a professional engineer licensed in Connecticut.
  - 2. Manufacturer's product literature and performance data for all specified equipment, sufficient to verify compliance to specification requirements.



3. Manufacturer's certification of prototype testing.
4. Manufacturer's published warranty documents.
5. Manufacturer's installation instructions for all specified equipment.

## PART 2 - MATERIALS AND PRODUCTS

### 2.1 PRECAST CONCRETE PUMP STATION STRUCTURES

- A. The pump station structures shall be constructed to the lengths, widths, and heights as shown on the contract drawings. The station shall be designed to adequately and safely support all live and dead loads to which the structure will be subjected and to withstand all conditions which may be encountered.
- B. Design calculations prepared by the State of Connecticut licensed professional engineer shall verify that the structures have been designed to withstand the burial depth, submergence due to high groundwater (assumed at the ground surface) and the dead and live loads (H2O wheel load) anticipated for the station. The station structures shall have an adequate wall, floor and roof thickness and steel reinforcement sufficient for the depth of burial shown on the drawings.
- C. Design computations for uplift forces shall contain a minimum factor of safety of 1.25. When required for counter-flotation, as determined by the buoyancy calculations, the structures shall be designed with a "hold-down" system to satisfactorily withstand up-lift pressures exerted on the chambers.
- D. Roof slab/ceiling slab designs shall account for the loads imposed on the slab by the weight of the pumps or other wheel loadings.
- E. Concrete used in the manufacture of components shall meet the following criteria:
  1. Cement shall be high early strength Portland cement, Type III, conforming to ASTM C-150.
  2. Fine aggregate shall consist of washed natural sand conforming to ASTM specification C-33.
  3. Coarse aggregate shall consist of 3/4" well-graded crushed stone conforming to ASTM specification C-33.
  4. Air entrainment shall be 4.5% plus or minus 1%. A superplasticizer shall be used, and concrete shall be placed at a slump of 6" plus or minus
- F. The concrete used for the structural components shall attain a minimum, 28-day compressive strength of 5,000 PSI.

- G. Concrete fill used in the floors if required (to form fillets and sloped floors) shall comply fully with this subsection except that the concrete shall attain a minimum, 28-day compressive strength of 5,000 PSI.
- H. Reinforcing steel used in the manufacture of components shall meet the following requirements:
  - 1. The steel shall be new billet steel, deformed steel bars conforming to ASTM A-615 (latest revision), Grade 60. Welded steel wire fabric reinforcing shall conform to ASTM A-185 (latest revision).
  - 2. The minimum cover of reinforcement shall be 1 ½" inch.
  - 3. Each pre-cast module shall be provided with formed male & female joints to insure accurate joint surfaces and tolerance for a watertight seal. All joints between adjoining pre-cast modules shall be primed at the factory and sealed by the pump station manufacturers personal when modules are set in the field utilizing a vulcanized butyl rubber compound sealant conforming to AASHTO M-198 (latest revision). All surfaces of the pre-cast structure shall be smooth, even and free from roughness, irregularities and other defects, and shall be suitable for receiving the interior and exterior finishes specified elsewhere herein.

## 2.2 ACCESS COVERS

- A. The floor access door shall be the size being specified on the plans. Door leaf shall be 1/4-inch thick steel diamond plate reinforced for an AASHTO H-20-44 wheel load. Upon request, the Manufacturer shall provide structural calculations showing that the door design meets the loading requirements of AASHTO H-20-44.
- B. The frame shall be 1/4-inch thick channel frame with anchors welded to the frame for casting into concrete.
- C. The floor access door shall be equipped with a flush steel lifting handle that does not protrude above the cover, and a 316 stainless steel hold open arm with a red vinyl grip that automatically locks the cover in its upright, open position. An aluminum skirt shall be welded to the frame to provide a combined height equal to the depth of the concrete slab.
- D. The door shall have tamper-resistant hinges with recessed stainless steel pins and lugs. The door shall have open, stainless steel, horizontal, compression springs to assist in opening the door and reducing the force during closing. The floor access door shall have mil finish on the exterior exposed surfaces. Cast in surfaces shall have a bitumastic coating. Installation shall be in accordance with the Manufacturer's attached instructions. The entire frame, including the seat on which the reinforcing rests, shall be supported by concrete or other material designed to support the specified load.

- E. The door shall be manufactured and assembled in the United States. Manufacturer shall guarantee the door against defects in materials and workmanship for a period of five years.
- F. Installation shall be in accordance with the Manufacturer's attached instructions. The entire frame including the seat on which the reinforcing rest shall be supported by concrete or other material designed to support the cover loading. The door shall be manufactured and assembled in the United States. Manufacturer shall guarantee the door against defects in materials and workmanship for a period of ten (10) years.
- G. The hatch shall have a fall through prevention system capable of withstanding a load of 300 pounds per square foot. It will consist of an aluminum grate with 5" x 5" openings that rotates on hinges that are welded to the hatch frame. When the grate is lifted to its open position, it will lock in place and serve as a barrier. The door cannot be closed until the Hinged Aluminum Safety Grate is completely closed.

### 2.3 PIPING AND VALVING

- A. Pipe shall be a call class of 42222 for pipe and fittings shall ASTM D 3965 and shall conform to National Sanitation Foundation (NSF) Standard 14. Pipe shall be iron pipe size (IPS) conforming to ASTM F 268. Fittings shall conform to ASTM D 2661.
- B. All pipe and fittings to be produced by a single manufacturer and to be installed in accordance with Manufacturer's recommendations and local code requirements. Buried pipe shall be installed in accordance with ASTM D 2321 and STTM F 1668. Solvent cement shall conform to ASTM d 2235. All pipe penetrations through the concrete shall be sealed. Piping within the chambers shall be supported as necessary.
- C. Ball check valves shall be of heavy cast iron A126 Class B construction, epoxy coated, screwed cap and corrosion-resistant phenolic sinking ball. The valve shall provide full-flow performance with a minimum of turbulence or pressure loss. The valves shall be rated 150 PSI WOG.
- D. Ball valves shall be thermoplastic True Union 2000 Standard type manufactured to ASTM F1970 and constructed from PVC Type I, ASTM D 1784 Cell Classification 12454. O-rings shall be EPDM. All valves shall have Safe-T-Shear® stem with an O-ring stem seal. All handles shall be polypropylene. All union nuts shall have Buttress threads. All seal carriers shall be Safe-T-Blocked®. All EPDM valves shall be certified by NSF International for use with potable water. All 2" valves shall be pressure rated to 235 psi, all 3" valves to 150 psi for water @ 73°F.

## 2.4 SUBMERSIBLE CHOPPER PUMPS

### A. DESCRIPTION

1. The Factory Fabricated Pump Station Mfg. shall furnish two (2) submersible explosion-proof wet pit chopper pumps and all appurtenances as specified. The pump shall be specifically designed to pump waste solids at heavy consistencies without clogging or dewatering of the solids. Materials shall be chopped and conditioned by the pump as an integral part of the pumping action. The pump must have demonstrated the ability to chop through and pump high concentrations of solids such as plastics, heavy rags, grease and hairballs, wood, paper products and stringy materials without clogging, both in tests and field applications.

### B. QUALITY ASSURANCE AND PERFORMANCE AFFIDAVIT

1. The Factory Fabricated Pump Station Mfg. shall submit the Manufacturer's standard warranty and a performance affidavit for equipment to be furnished in accordance with this section. The warranty for workmanship and materials shall be Manufacturer's standard for 1 year from startup, not to exceed 18 months from factory shipment. In the performance affidavit, the Manufacturer must certify to the Contractor and the Owner, that the Contract Documents have been examined, and that the equipment will meet in every way the performance requirements set forth in the Contract Documents for the application specified. Shop drawings will not be reviewed prior to the receipt by the Engineer of an acceptable performance affidavit. The performance affidavit must be signed by an officer of the company manufacturing the equipment and witnessed by a notary public. The performance affidavit must include a statement that the equipment will not clog or bind on solids typically found in the application set forth.

### C. PROVEN RECORD OF PERFORMANCE

1. It is the express intent of these specifications to accurately describe equipment that is a regular production item, and that has a proven record of performance in identical (not just similar) applications in other heavy sewage application pump stations. The chopper pump manufacturer shall have a minimum of twenty (20) years of documented experience in the design and production of chopper pumps of all types, and not less than five (5) years of experience in the production of the exact equipment as specified herein.
2. At least five (5) of the reference installations provided shall be of the exact model pump proposed for use. References shall be pumps that have been used in continuous service for a period of no less than three (3) years. The only equipment that is in service at the time of referral shall be considered valid. Pumps that have been removed from service for any reason will not be considered as references. Telephone numbers and contact names shall be provided for any/all references upon request from the Engineer. Provision of performance bonds or other means of circumventing the above requirements for historical

references and verification of past performance in identical applications are not considered an acceptable means of verifying the manufacturers' experience. **Grinder pumps and/ or cutter pumps utilizing a secondary cutter tooth on the volute suction will not be allowed.**

D. SERVICE CONDITIONS

1. The pumps shall be designed as follows:
  - a. 60 GPM
  - b. 48"TDH
  - c. 5 HP
  - d. 1725 RPM:
  - e. 54' Shut Off Head
  - f. Explosion-Proof 208 Volt Three Phase

E. PUMP CONSTRUCTION

1. Casing: Shall be of a volute design, spiraling outward to the Class 125 flanged centerline discharge. Casing shall be ductile cast iron with all water passages to be smooth, and free of blowholes and imperfections for good flow characteristics. Casing shall include a replaceable Rockwell C 60 alloy steel cutter to cut against the rotating impeller pump-out vanes for removing fiber and debris.
2. Impeller: Shall be a semi-open type with pump-out vanes to reduce seal area pressure. Chopping of materials shall be accomplished by the action of the cupped and sharpened leading edges of the impeller blades moving across the cutter bar at the intake openings, with a set clearance between the impeller and cutter bar of 0.015-0.025" cold. The impeller shall be cast alloy steel heat treated to minimum Rockwell C 60 and dynamically balanced. The impeller shall have no axial adjustments and no set screws. Pumps with open type impellers or impellers without modified pump-out vanes to shear against the upper cutter shall not be considered as equal.
3. Cutter Bar: Shall be recessed into the pump casing and shall contain at least 2 shear bars extending diametrically across the intake opening to within 0.010-0.030" of the rotating cutter nut tooth, for the purpose of preventing intake opening blockage and wrapping of debris at the shaft area. Chopper pumps utilizing individually mounted shear bars shall not be acceptable. Cutter bar shall be alloy steel heat-treated to minimum Rockwell C 60.
4. Upper Cutter: Shall be threaded into the casing or back-plate behind the impeller, designed to cut against the pump-out vanes and the impeller hub, reducing and removing stringy materials from the mechanical seal area. The upper cutter shall have no more than two anvils that are positioned as closely as possible to the center of shaft rotation to minimize cutting torque, the potential for binding, and nuisance motor tripping. The ratio of upper cutter cutting diameter to shaft diameter in the upper cutter area of the pump shall be 3.0 or less. Upper cutter shall be cast alloy steel heat treated to minimum Rockwell C 60.

5. Cutter Nut: The impeller shall be secured to the shaft using a cutter nut, designed to cut stringy materials and prevent binding using a raised, rotating cutter tooth. The cutter nut shall be cast alloy steel heat treated to minimum Rockwell C 60. Due to the solids handling demand in this application, impeller securing devices that lack the ability to cut debris from the pump suction shall not be considered as equal.
6. Pump Shafting: Shafting shall be heat-treated alloy steel, with a minimum diameter of 1.5 inches in order to minimize deflection during solids chopping. Mounting of the pump impeller directly to the motor shaft shall not be allowed on this project as these results in an unacceptable overhang distance from the impeller to the lowest mechanical seal.
7. Bearing Housing: Shall be ductile cast iron, and machined with piloted bearing fits for concentricity of all components. The piloted motor mount shall securely align the motor on top of bearing housing.
8. Thrust Bearings: Shaft thrust in both directions shall be taken up by two back-to-back mounted single-row angular contact ball bearings, or a matched set of face to face tapered roller bearings, with a minimum L-10 rated life of 100,000 hours. The overhang from the centerline of the lower thrust bearing to the seal faces shall be a maximum of 1.7". A third mechanical seal (two in motor) shall also be provided to isolate the bearings from the pumped media. The third seal, as well as the thrust bearings, shall be oil bath lubricated in the bearing housing by ISO 46 hydraulic oil. Shaft overhang exceeding 1.7 inches from the center of the lowest thrust bearing to the seal faces shall be considered unacceptable.
9. Pump Mechanical Seal: The mechanical seal is to be manufactured and warranted by the pump manufacturer. Pump manufacturer is to have at least 15 years' experience producing the mechanical seal and a documented history of 10 years of installations in the same application as specified. The mechanical seal shall be located immediately behind the impeller hub to maximize the flushing available from the impeller pump-out vanes. The seal shall be a cartridge-type mechanical seal with Viton O-rings and silicon carbide (or tungsten carbide) faces. This cartridge seal shall be pre-assembled and pre-tested so that no seal settings or adjustments are required from the installer. Any springs used to push the seal faces together must be shielded from the fluid to be pumped. The cartridge shall also include a 17-4PH, heat-treated seal sleeve, and a ductile cast iron seal gland. Submersible pumps that expose the lower motor seal to the sewage are not considered as equal.
10. Automatic Oil Level Monitor: An oil level switch shall be mounted at the top of the wet well, with a hose feeding down to the side of the bearing housing to monitor oil level and shut off the motor in event of low oil level. A relay shall be included for mounting in the motor control panel.
11. Shaft Coupling: The submersible motor shall be close-coupled directly to the pump shaft using a solid sleeve coupling, which is keyed to both the pump and motor shafts. Slip clutches and shear pins between the shaft and the motor are considered unacceptable.

12. Stainless Steel Nameplate: Shall be attached to the pump giving the Manufacturer's model and serial number, rated capacity, head, speed, and all pertinent data.

F. SUBMERSIBLE ELECTRIC MOTOR

1. The submersible motor shall be U/L FM listed and suitable for Class I, Group C & D, Division I hazardous locations, rated at 5 HP, 1725 RPM, 208 Volts, 60 Hertz, 3 phase operation with 1.15 service factor (1.0 for Continuous In-Air) with Class F insulation.
2. Motor shall have tandem mechanical seals in an oil bath and dual moisture sensing probes. Moisture probes must be connected to indicate water intrusion. The lower motor seal shall be exposed only to the lubricant in the pump bearing housing, with no exposure to the pumped media.
3. Motor shall include two normally closed automatic resetting thermostats connected in series and embedded in adjoining phases. The thermostats must be connected per local, state, and/or the National Electric Code to maintain a hazardous location rating and to disable motor starter if overheating occurs.
4. Motor frame shall be cast iron, and all external hardware and shaft shall be stainless steel. Motor shall be sized for non-overloading conditions.

G. GUIDE RAIL SYSTEM

1. Provide a Non-Sparking guide rail system consisting of two 304 stainless steel guide rails, cast ductile iron pump guide bracket, cast ductile discharge elbow with mounting feet and Class 125 flanges, 316 stainless steel upper guide rail mounting bracket.

2.5 PROCESS INSTRUMENTATION AND CONTROL

A. SCOPE

1. Custom control panel unit with a NEMA 4X fiberglass enclosure, main power breaker interlock, digital level controller with submersible transducer, circuit breakers, intrinsically safe barriers, and back-up float level control system.
  - a. NEMA 4X fiberglass control panel enclosure with the following:
    - 1) Sealed seams without holes or knock-outs
    - 2) Padlocking hasp 316 series stainless steel
    - 3) Data pocket on the interior of the door
    - 4) Copper flashed steel collar studs
    - 5) Aluminum inner dead-front door
    - 6) Seamless foam gasket
  - b. Main power circuit breaker inter-lock with the following:
    - 1) Allows only one breaker in the on position
    - 2) Sliding locking tab
    - 3) Must be used with Square "D" QOU series breakers only



- c. ATLAS 4XR digital level controller consisting of a 4-20 mA transducer operated pump controller featuring a 32 alpha-numeric LCD display for level, status, and set-point information. It shall have a simple menu structure for easy display and modification of Set-points and set up configuration. Built-in software, so no programming is required. Alternation selection switch on the front panel to turn alternation on or select the lead pump is alternation is off. The controller shall include the following:
  - 1) Built-in elapsed time meters for all pumps
  - 2) 4-20 mA main sensor input with a loop power supply with an easy connection to the transducer.
  - 3) Pump seal fail and over-temperature inputs with an indication
  - 4) Scalable 4-20 mA level output transmitter
  - 5) Built-in single float backup system
  - 6) Auxiliary input
  - 7) Built-in horn relay with input for the external mute button
  - 8) Relay outputs for both high and low-level alarms
  - 9) Individually selectable set-points for up to three pumps
  - 10) All inputs are filtered and transient protected
  - 11) UL/UL 698A Listed
- d. Submersible level transducer with 100 feet of cable providing temperature compensated analog output proportional to the height of the liquid column above the transmitter. The transducer shall be as follows:
  - 1) Accuracy +/-1% FS T.E.B.
  - 2) Pressure rating shall be 0 to 10 foot of water column
  - 3) Compensated temperature range 0 – 60 degrees 'C"
  - 4) Operating temperature range -10 – 70 degrees "C"
  - 5) Pressure output shall be 0-5 VDC 4-20 mA
  - 6) All wetted materials shall be 316SS, polyamide, fluorocarbon
  - 7) Electrical to be termination vented Hytrel cable
  - 8) Power supply to be 8 – 28 VDC
  - 9) Output power two-wire 4-20 mA
- e. Circuit breakers as follows:
  - 1) Surface-mounted
  - 2) Interrupt rating 5K at 240VAC
- f. The intrinsic safe barrier with the following features:
  - 1) Dual-channel 24 VDC with 26 VDC per channel
  - 2) Pole reversal protection
  - 3) 160mA replaceable fuse
  - 4) Internal resistance 280 ohms, channel 1 and 1Vdrop channel 2
- g. Intrinsic safe multi-function controller with the following:
  - 1) Normally open or normally closed switches



- 2) Class I, Division I & II, Group A, B,C & D
  - 3) Supply Voltage 120 VAC
  - 4) Invert logic capable of being direct or inverted
  - 5) Green LED lights
  - 6) Sensitivity 4/7 – 100K
  - 7) U.L. 913 rated
- h. Battery back-up and charge as follows:
- 1) 8 amp hour 12 VDC battery sealed lead acid design with quick-connect terminals
  - 2) Battery charger 12 VDC Model FLC-2207 with quick recharge capabilities or float charge.
- i. An exterior mount alarm light shall be constructed of a shatter-resistant Lexan. The light shall be rated NEMA 4X with a one-piece heavy-duty porcelain lamp holder with a 25-watt rough service bulb. The light shall be mounted on the top of the enclosure. The buzzer shall be mounted to the exterior of the enclosure, rated for outdoor service. The alarm shall illuminate and sound as a common alarm. The light and horn, when installed within a Main Electrical Enclosure, shall be installed not on the controller but on the exterior of the main electrical enclosure.
- j. Autodialer system as follows:
- 1) The Automatic dialer shall be a self-contained microprocessor-controlled system capable of monitoring up to 4 alarm channels, temperature and AC power. The system shall be configured for operation by the user by means of the built-in keypad. The system shall allow limited access to programming remotely by touch-tone telephone. The system shall have one on-board output. Characteristics of Input and Output channels include Dry Contact Input and Digital Relay Output.
  - 2) Upon detection of any alarm or status change, the system shall commence dialing telephone numbers and deliver a voice message identifying and describing the alarm condition(s). The alarm message shall be delivered in digitized human voice using messages recorded by the user. The system will continue to call telephone numbers in succession until a positive acknowledgment of the alarm message is received.
  - 3) Acknowledgment is accomplished by depressing tone keys from the called telephone, or by calling the system back within a programmed time period. The alarm may also be acknowledged using the local keypad. In addition, the system shall be able to receive incoming telephone calls. Upon answering, the system shall recite a status report and allow access to remote operation and programming.
  - 4) The system shall be FCC and DOC registered for direct connection to the telephone network.

- 5) The system shall have a one year warranty from the Manufacturer. The system shall have the following channel attributes and features:
- a) Inputs:  
The system shall come standard with 4 dry contact input channels, configurable as NO or NC digital dry contact using 2mA loop current. The system shall have the following built-in monitoring features:
- AC power failure detection
  - Temperature with pre-wired 2.8K Thermistor (-0 F to 175 F)
- All monitored channels, including built-in monitoring features, shall allow local keypad programming of pertinent operational data including, but not limited to:
- Input type (NO/NC)
  - High and Low limits (temperature)
  - Input recognition time (0 seconds to 272 minutes)
  - Enable/disable for each channel to dial out for alarm
- b) Output: The system shall have one built-in SPDT form C 5A 125 VAC relay output. The output may be programmed to switch automatically or manually.
- c) Communication Features:
1. Telephone Specifications: The system shall connect to a standard 2-wire telephone line using pulse or tone, with a loop start only. The system shall recognize ringer frequencies from 16 to 60 Hz. No leased or dedicated lines shall be required. The system shall also be capable of being used on the same telephone line as other answering devices. Call progress detection shall ensure that the alarm dial out is not hindered by no answers or busy signals.
  2. Telephone Numbers: The system shall be capable of dialing up to eight (8) telephone numbers, 32 digits each. The system shall allow local keypad programming of the following telephone dialing information:
    - Dialing method (Pulse or tone)
    - Message repetitions (0 to 255)
    - Maximum number of calls (0 to 255)
    - Call delay time (0 seconds to 255 seconds)
    - Inter-call delay time (0 seconds to 272 minutes)
    - Redial on busy (enable/disable)
  3. Voice Messages: The System shall have the ability to record, store and reproduce voice messages and to use those messages to articulate the location and status of the monitored channels. In the absence of user-recorded voice messages, the system shall articulate channel status using the internally resident vocabulary. All digitized speech

message data shall be stored in non-volatile memory with a 3V lithium battery backup. Such battery backup shall be capable of protecting speech memory for at least 2 years of a complete power outage. There shall be one recorded identification message for the system, and one recorded alarm message for each input channel. Message length shall be 8 seconds per input channel and 10.5 seconds for the identification message.

4. Beeper/Pager Dial-out

The system shall be capable of intelligently dialing out to a numeric beeper or pager. The dialing sequence shall be programmable such that the pager number is dialed, the system waits for the telephone to be answered, and then additional identification DTMF digits are transmitted.

5. Line Seizure Feature: The system automatically seizes control of the phone line to make an alarm phone call when the alarm occurs. All other calls including current calls will disconnect and all extensions will be disabled. Extensions will remain cut off until the alarm is acknowledged.

d) Programming:

1. Local Programming: The System shall contain an integral, sealed keypad for the purpose of locally programming all system data. Programming is assisted by synthesized voice guidance.

2. Remote Programming: The system shall be remotely programmable using a standard touch-tone telephone. Remote programming shall be aided by menu-style voice guidance. The following parameters may be remotely programmed:

- a. Alarm messages
- b. Identification message
- c. Turn output on/off
- d. Disable/enable inputs

e) Remote Operation Features:

1. Status Report: The system shall allow the user to call into the unit at any time using any standard telephone to obtain a full status report of all monitored channels including present temperature and listen-in to on-site sounds. The status report shall be articulated using the resident voice-synthesized English vocabulary, in combination with digitized user-recorded voice messages.

2. Acknowledgment: An alarm on any monitored channel may be acknowledged remotely by pressing tones on a touch-tone telephone keypad or by calling the system hack within a specified time period.

An alarm may also be acknowledged locally using the built-in keypad.

- f) Enclosure: The system shall be housed in a NEMA-4X fiberglass enclosure with a latched clear cover and shall be internally constructed to facilitate field upgrades, repair, and maintenance.
- g) Power: The system shall be provided with a UL listed 12V AC power transformer that the user may plug into a 1 17V AC outlet, +20%, 60Hz.
- h) Local Visual Indication: Each input shall have a corresponding LED that will indicate the alarm and acknowledgment status of each input.
- i) Battery Backup: The system shall have a built-in 12V 9 All sealed lead-acid rechargeable battery. This battery shall support approximately 12 hours of continued system operation in the absence of AC power.
- j) Electrical Protection: Power and telephone connection shall have internal spike and surge protection using metal oxide varistors. The dry contact inputs shall be optically isolated.
- k) Additional Electrical Surge Protection: Additional Power and Telephone line surge protection shall be available from the Manufacturer. When so installed, the system shall be fully warranted against any damage caused by transient surges entering the system through Power or Telephone lines.
- l) Environmental: The system shall function over an operating range of 32 F - 120 F at up to 90% RH, non-condensing.

## PART 3 - EXECUTION

### 3.1 EARTHWORK

- A. Refer to Division 31 Section 312333 "Trenching and Backfilling" for excavating, trenching, and backfilling.
- B. Excavate sufficient width and length for the pump station to the depth determined by tank inlet elevation. Provide a level bottom.
- C. Provide 18-inch thick size  $\frac{3}{4}$ " clean crushed stone conforming to CT DOT FORM 817, M.01. #6.
- D. Backfill with suitable soil. Backfill around the septic tank soil in an 8-inch lift and compact to 95% of Standard Proctor Density.

### 3.2 INSTALLATION

- A. The requirements of all applicable local and state authorities shall be followed by the Contractor.
- B. The Contractor must notify "CALL BEFORE YOU DIG" (1-800-922-4455 or "811") prior to the start of any excavation.

### 3.3 CONTRACT CLOSEOUT

#### A. STARTUP SERVICES

- 1. The pump station manufacturer shall provide a manufacturer's representative to test each pump station system at startup. A report shall be made to the engineer before final acceptance.

#### B. OPERATION AND MAINTENANCE INSTRUCTION MANUALS

- 1. Furnish four (4) complete sets of Operations & Maintenance Manuals which are job-specific at the time of startup & one (1) electronic version.
- 2. The manuals shall be prepared with clear instructions, which will enable the owner's personnel to operate and maintain the complete pump station system including the generator set and auto-dialer system.
- 3. The manuals shall be bound in a three-ring vinyl binder or plastic binding combs with a heavy gauge clear vinyl overlay on the front cover. A title sheet tabulating information including: name and location of project and manufacturers name and address shall be placed in these pockets. The manuals shall contain an index which lists and locates all enclosed literature and drawings. The manuals shall be comprehensive and contain as a minimum the following:
  - a. Descriptive operating instructions for all system components.
  - b. Instructions that are relevant to all modes of equipment operation.
  - c. Service and troubleshooting instructions as may be available from select manufacturers of equipment supplied.
  - d. Procedures for the adjustment of equipment at initial start-up, during routine preventative maintenance, and following replacement or repair.
  - e. Instructions for testing and calibration of electronic components required to determine proper performance.
  - f. As-Built mechanical drawings and dimensional information showing the actual layout and location of all major equipment components within the structures.
  - g. Maintenance requirements for all system components.

3.4 WARRANTY

- A. The Pump Station Installer must provide a 2-year warranty of the installed pump station system.

3.5 AS-BUILT

- A. Final As-built of all underground structures and pipes location and elevations to be prepared by a CT Licensed surveyor in a paper, Mylar and AutoCad format, signed and sealed accuracy class A-2/T-2, and submitted to the Town of Thomaston WPCA and Property the Owner.

END OF SECTION 333200

## SECTION 334000 – STORM SEWER UTILITIES

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Underground storm sewer system complete, ready for operation, including all piping, structures, and all other incidentals.

#### 1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
- B. State of Connecticut Department of Transportation “The Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, as amended and merged with the July 2019 supplemental specifications.

#### 1.3 RELATED SECTIONS

- A. Division 3, Concrete Specifications for concrete.
- B. Section 312000 “Earthmoving” for Excavation”.
- C. Section 312333 “Trenching and Backfilling” for Detectable Warning Tape, and Backfill.
- D. Section 315000 “Excavation Support and Protection” for Shoring, Sheeting, and Bracing.
- E. If there any discrepancies found between these specifications and related drawings and details, the most restrictive requirement and/or material/part shall be applied by the Contractor without compensation.

#### 1.4 ABBREVIATIONS

- A. HDPE: High-density polyethylene
- B. PE: Polyethylene
- C. PVC: Polyvinyl chloride plastic

## 1.5 SUBMITTALS

- A. Product Data: For the following:
1. PVC Polyvinyl chloride pipe as shown on the drawings.
  2. HDPE- High-Density Polyethylene pipe as shown on the drawings.
  3. Storm Cleanouts as shown on the drawings.
  4. Manholes as shown on the drawings.
  5. Catch basins as shown on the drawings.
  6. PVC yard drains and slot drains as shown on the drawings.
  7. Subsurface retention/detention basins as shown on the drawings.
  8. Water Quality devices as shown on the drawings.
  9. Stormwater discharge chamber as shown on the drawings.
  10. Geotextile as shown on the drawings.
  11. Non- pressure transition couplings and fittings.
  12. Concrete encasement for piping, if require.
  13. Riprap and River Jack Stone as shown on the drawings.
- B. Shop Drawings: Include plans, elevations, details, and attachments for the following:
1. Pre-cast concrete structures, including inserts, baffles, offsets, pipes inverts in and out, frames, covers, grates, and other that apply to concrete structures.
  2. Subsurface detention basins, including piping, fittings, inverts in and out, inspection port, cleanouts, frames, covers, grates, geotextile, stone, and other that applies to the basin.
  3. Slot Drains, catch basins, inverts in and out, tamper-resistant cast iron grates and other that apply to drains.
  4. Cleanouts, including frames, covers, grates and other that apply to cleanouts.
  5. PVC yard drains with cast iron grates and other that applies to drains.
- C. Coordination Drawings: Show manholes and other structures, pipe sizes, locations, and elevations. Include details of underground structures and connections. Show other piping in the same trench and clearances from sewerage system piping. Indicate interface and spatial relationship between piping and proximate structures.
- D. Coordination Profile Drawings: Show system piping in elevation. Draw profiles at a horizontal scale of not less than 1 inch equal 40 feet (1:500) and a vertical scale of not less than 1 inch equals 4 feet (1:50). Indicate underground structures and pipes. Show types, sizes, materials, and elevations of other utilities crossing system piping.
- E. Design Mix Reports and Calculations: For each class of cast-in-place concrete.
- F. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.



- G. Performance Documentation
1. Stormwater quality chambers. The following documentation must be submitted by the Contractor and approved by the Engineer prior to the manufacture and delivery of any materials.
    - a. Laboratory Data. The Stormwater quality structures supplier shall provide documentation of Total Suspended Solids (TSS) removal efficiency from laboratory testing conducted on the supplier's full-scale system. The documentation shall include:
      - 1) TSS removal efficiency versus operating rate for the full operating range of the stormwater treatment system for 50-micron particle size.
      - 2) TSS removal calculations for each system specified herein. The calculations must demonstrate that the system(s) is capable of achieving a net annual TSS removal efficiency as required by local regulations and as based upon 50-micron particle size and the best available rainfall data for the project site location.
    - b. Field Test Data. The Stormwater quality structures supplier shall provide documentation of TSS removal efficiency from field testing conducted on an installed system. The documentation shall be in accordance with the following:
      - 1) The testing and documentation shall have been conducted by an independent third party.
      - 2) The testing and documentation shall include at least 10 storms.
      - 3) The testing and documentation must show TSS removal results that meet or exceed the performance requirements for the system(s) specified herein.
    - c. Manufacturing Experience. The Stormwater quality structure supplier shall provide evidence of at least 5 years of successful product design and use. The supplier shall provide an installation list of projects, model sizes installed and installation dates where the same type systems as specified herein have been designed and produced by the supplier.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store plastic structures, pipes, and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle pre-cast concrete and PVC structures, and other structures according to manufacturer's written rigging instructions.

## 1.7 PROJECT CONDITIONS

- A. It is the contractor's responsibility and expense to engage a Professional Engineer licensed in the State of Connecticut to perform supervision of the installation of the Underground stormwater retention/detention system. The installation of all Underground stormwater retention/detention system on the site to be done under the supervision of this engineer.
- B. After construction is completed, the engineer who supervised the installation of the Underground stormwater retention/detention system on the site is to submit to the Owner written certification that the system was installed as per the approved design.
- C. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
  - 1. Notify Architect not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Architect's written permission.

## PART 2 - MATERIALS AND PRODUCTS

### 2.1 STORM SEWER PIPES AND FITTINGS

- A. HDPE PIPE AND FITTINGS
  - 1. This specification describes 4- through 60-inch (100 to 1500 mm) HDPE ST IB pipe (per AASHTO) for use in gravity-flow land drainage applications.
  - 2. Pipe Requirements:
    - a. HDPE ST IB pipe (per AASHTO) shall have a smooth interior and annular exterior corrugations.
    - b. 4- through 60-inch (100 to 1500 mm) pipe shall meet AASHTO M252, TYPE S or SP, or ASTM F2306.
    - c. Manning's "n" value for use in design shall be 0.012.
  - 3. Joint Performance:
    - a. Pipe shall be joined using a bell & spigot joint meeting AASHTO M252, ASSHTO M294 OR ASTM F2306. The joint shall be spoil-tight and gaskets for diameters 12 through 60-inch shall meet the requirements of ASTM F477. For diameters 4 through 10-inch, the joint shall be soil-tight using an engaging dimple connection. Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.
  - 4. Fittings:
    - a. Fittings shall conform to AASHTO M252, AASHTO M294, or ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle

gasket meeting the soil-tight joint performance requirements of AASHTO M252, AASHTO M294, or ASTM F2306.

5. Material Properties:
  - a. Material for pipe and fitting production shall be high-density polyethylene conforming with the minimum requirements of cell classification 424420C for 4- through 10-inch diameters, and 435400C for 12- through 60-inch diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 4%. The 12- through 60-inch virgin pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306 respectively. The 12- through 60-inch (300 to 1500 mm) pipe material shall comply with the notched constant ligament-stress (NCLS) test as specified in Sections 9.5 and 5.1 of AASHTO M294 and ASTM F2306, respectively.
  
6. Installation:
  - a. Installation shall be in accordance with ASTM D2321 and Manufacturer recommended installation guidelines, with a minimum cover in trafficked areas for 4- through 48-inch diameters shall be two foot and for 60-inch diameter, the minimum cover shall be 2 ft. in single run applications.
  - b. Use flowable fill to install risers 6 ft. and higher.
  - c. Bedding 6-inch of bedding material for pipes 12” to 24” and 12-inch of bedding from pipes 30” to 60”. Bedding materials shall conform to CTDOT Form 817, including July 2019 supplemental, section M.01. #6 clean crushed stone and shall be compacted to 90% Standard Proctor density.
  - d. Backfill to spring line and initial backfill shall consist of CTDOT Form 817, including July 2019 supplemental, section M.01. #6 clean crushed stone (compacted).

## 2.2 PVC DISTRIBUTION PIPE AND FITTINGS

- A. For distribution pipes and fittings where indicated on drawings and details: PVC SDR 35, ASTM D 3034. Rubber compression gasket couplings, ASTM D 3139 or equal. Or solvent weld couplings/fittings using proper two-step PVC solvent solution procedure.
  
- B. For distribution pipes and fittings where indicated on drawings and details: PVC SCH.40, ASTM D 1785 or ASTM D 2665. Rubber compression gasket couplings, ASTM D 3139 or equal. Or solvent weld couplings/fittings using proper two-step PVC solvent solution procedure.

C. Installation:

1. Installation shall be in accordance with ASTM D2321 with a minimum cover in trafficked areas for 4- through 12-inch diameters shall be 2 ft. in single run applications.
2. Provide 6-inch of bedding material in earth and 12-inch of bedding material in rock for PVC pipes 4" to 12". Bedding materials shall conform to CT DOT Form 817, including July 2019 supplemental, section M.08.03, and shall be compacted to 90% Standard Proctor density. If groundwater is encountered, the Contractor to use No. 6 stone conforming to CT DOT FORM 817, including July 2019 supplemental, Article M.01. instead of sand or sandy soil.
3. Backfill to spring line and initial backfill as show on details shall consist of Class 2 and shall be compacted to 90% Standard Proctor density.

## 2.3 NONPRESSURE TRANSITION COUPLINGS

- A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground non-pressure piping. Include ends of the same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
- B. Sleeve Materials:
1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
- C. Shielded, Flexible Couplings:
1. Description: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
- D. Ring-Type, Flexible Couplings:
1. Description: Elastomeric compression seal with dimensions to fit inside the bell of larger pipe and for spigot of smaller pipe to fit inside the ring.

## 2.4 BEDDING AND BACKFILL MATERIAL

- A. For HDPE pipes:
1. Bedding 4-inch of bedding material for pipes 12" to 24" and 6-inch of bedding from pipes 30" to 60". Bedding materials shall conform to CTDOT Form 817, including July 2019 supplemental, section M.08.03, and shall be compacted to 90% Standard Proctor density. If groundwater is encountered, the Contractor to use No. 6 stone conforming to CTDOT Form 817, including July 2019 supplemental, Article M.01. instead of sand or sandy soil.

2. Backfill to spring line and initial backfill shall consist of Class 1 (compacted) as defined by ASTM D2321 per manufacturer specification or flowable fill, strength as recommended by the manufacturer. The contractor shall provide documentation for material specifications to the engineer.

B. For PVC pipes:

1. Provide 6-inch of bedding material in earth and 12-inch of bedding material in rock for PVC pipes 4" to 12". Bedding materials shall conform to CTDOT Form 817, including July 2019 supplemental, section M.08.03, and shall be compacted to 90% Standard Proctor density. If groundwater is encountered, the Contractor to use No. 6 stone conforming to CTDOT Form 817, including July 2019 supplemental, Article M.01. instead of sand or sandy soil.
2. Backfill to spring line and initial backfill as show on details shall consist of Class 2 and shall be compacted to 90% Standard Proctor density.

C. For structures:

1. Bedding for ALL stormwater structures use 3/4" clean crushed stone conforming to the requirements of Section M.01.for No.6 stone of the State of Connecticut Department of Transportation "Standard Specifications for Roads, Bridges and Incidental Construction", Form 817, including current July 2019 supplemental and edition. Including but not limited to: retention basin, discharge structure, water quality device, catch basin, manhole, yard drain, storm cleanouts, and all other underground stormwater structures.

## 2.5 GEOTEXTILE FABRIC

- A. The geotextile shall be non-rotting, acid and alkali resistant and have sufficient strength and permeability for the purpose intended, including handling and backfilling operations. Fibers shall be low water absorbent. The fiber network must be dimensionally stable and resistant to delamination. The geotextile shall be free of any chemical treatment or coating that will reduce its permeability. The geotextile shall also be free of any flaws or defects, which will alter its physical properties. Torn or punctured geotextiles shall not be used. For each specific use, only geotextiles, which are already on the Connecticut Department of Transportation's "Qualified Products List" for the geotextile type, will be used. The Engineer reserves the right to reject any geotextile, which he deems unsatisfactory for a specific use. The brand name shall be labeled on the geotextile or the geotextile container. Geotextiles, which are susceptible to damage from sunlight or heat, shall be so identified by suitable warning information on the packaging material.

- B. Geotextiles susceptible to sunlight damage shall not be used in any installations where exposure to light will exceed 30 days unless specifically authorized in writing by the Engineer.

## 2.6 STORM SEWER STRUCTURES

### A. Standard Precast Catch Basins and Storm Manholes

#### 1. MANHOLES

- a. Heavy-Traffic HS-20, Pre-cast Concrete Manholes: ASTM C 478, pre-cast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints conforming to the requirements of Section 5.07 of the State of Connecticut Department of Transportation “Standard Specifications for Road, Bridge and Incidental Construction”, Form 817 as amended and including the current July 2019 supplemental specifications.
- b. Diameter: 48 inches minimum, unless otherwise indicated.
- c. Ballast: Increase the thickness of pre-cast concrete sections or add concrete to the base section, as required to prevent flotation.
- d. Base Section: 12-inch minimum thickness for floor slab and 8-inch minimum thickness for walls and base riser section and having a separate base slab or base section with an integral floor.
- e. Riser Sections: 8-inch minimum thickness, and lengths to provide depth indicated.
- f. Top Section: Eccentric-cone type, unless concentric-cone or flat-slab-top type is indicated. Top of the cone of the size that matches grade rings.
- g. Gaskets: ASTM C 443, rubber.
- h. Grade Rings: Include two or three reinforced-concrete rings, of 6 to 9-inch total thickness, that match 24-inch diameter frame and cover.
- i. Steps: Copolymer Polypropylene plastic steel-reinforced, as indicated. Cast or anchor into the base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
- j. Pipe Connectors: ASTM C 923, resilient, of the size required, for each pipe connecting to the base section.
- k. Frame and Cover: Gray Iron Casting, ASTM – A 48/ A 48M-03, class 30B, Painted, Suitable for AASHTO HS20-44 Highway Loading. Finish: bearing surface for frame & cover machined. The cover should be label “STORM DRAIN”.

#### 2. CATCH BASINS

- a. Normal-Traffic, HS-20 traffic loading, Pre-cast Concrete Catch Basins: ASTM C 478, pre-cast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints conforming to the requirements of Section 5.07 of the State of Connecticut Department of Transportation “Standard Specifications for Road,

Bridge and Incidental Construction”, Form 817 as amended and including the current July 2019 supplemental specifications.

- b. Base Section: 6-inch minimum thickness for floor slab and 8-inch minimum thickness for walls and base riser section and having a separate base slab or base section with an integral floor.
- c. Riser Sections: 8-inch minimum thickness, size as indicated, and lengths to provide depth indicated.
- d. Top Section: Pre-cast concrete, size as indicated.
- e. Gaskets: ASTM C 443, rubber.
- f. Grade Rings: Reinforced-concrete rings, of 6- to 9-inch total thickness.
- g. Steps: Copolymer Polypropylene plastic steel-reinforced, as indicated. Cast or anchor into the base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
- h. Pipe Connectors: ASTM C 923, resilient, of the size required, for each pipe connecting to the base section.
- i. Frames and Grates: ASTM A 48-83, gray iron castings designed for heavy-duty service, Type A, galvanized, conforming to the requirements of section M.08.02-5 of the State of Connecticut Department of Transportation “Standard Specifications for Road, Bridge and Incidental Construction”, Form 817 as amended and including the current July 2019 supplemental specifications
- j. Size: As indicated.
- k. Grate Free Area: Greater than 50 percent, unless otherwise indicated.

3. DISCHARGE CHAMBER

- a. Heavy-Traffic HS-20, Pre-cast Concrete Structures: ASTM C 478, pre-cast, reinforced concrete, of depth indicated, with provision for rubber gasketed joints conforming to the requirements of Section 5.07 of the State of Connecticut Department of Transportation “Standard Specifications for Road, Bridge and Incidental Construction”, Form 817, including current July 2019 supplemental.
- b. Inside Width: As indicated on the drawings.
- c. Base Slab Section: 6-inch minimum thickness for floor slab and 8-inch minimum thickness for walls and base riser section and having a separate base slab or base section with an integral floor.
- d. Risers: 4 feet diameter concrete manhole risers 8-inch minimum thickness, and lengths to provide depth indicated.
- e. Top Section: Flat-slab-top type is indicated. Top of the cone of the size that matches grade rings.
- f. Gaskets: ASTM C 443, rubber.
- g. Grade Rings: Reinforced-concrete rings to match the 30-inch diameter frame and cover.



- h. Steps: Copolymer Polypropylene plastic steel-reinforced, as indicated. Cast or anchor into the base, riser, and top section sidewalls with steps at 12- to 16-inch intervals. Omit steps for manholes less than 60 inches deep.
  - i. Pipe Connectors: ASTM C 923, resilient, of the size required, for each pipe connecting to the base section.
  - j. Discharge Chamber Frames and Covers: Gray Iron Casting, ASTM – A 48/ A 48M-03, class 30B, Suitable for AASHTO HS20-44 Highway Loading. Finish: bearing surface for frame & cover machined. The cover should be label “STORM DRAIN”.
4. PVC YARD DRAINS AND STORM CLEANOUTS
- a. PVC Basin:
    - 1) Used PVC Drain Basin. Materials shall conform to Form 817, Section M.08.01. Integrated cast gray iron frame and grade to match basin O.D. and rated for AASHTO HS-20 loading or as noted on the drawings. Construct 8–inch. thick minimum concrete slab for AASHTO H-20 loading around the frame in paved areas, as shown on details.
    - 2) Grates and frames shall be cast gray iron. Frame cast gray iron per ASTM A-48-83 Class 30B.
    - 3) Yard Drain basin to be custom manufactured according to plan details.
    - 4) Drainage connection stub joint tightness shall conform to ASTM D3212.
    - 5) Shop drawings shall be submitted to Engineer for approval.
    - 6) Backfill material below and to the side of the structure shall be ASTM D2321 Class 2 or size ¾” crushed stone or gravel and be placed uniformly in 6-inch. lifts and compacted to a min. of 90%.
5. TRENCH DRAINS WITH GRATE SYSTEMS
- a. General Requirements for Polymer-Concrete, Channel Drainage Systems: Modular system of pre-cast, polymer-concrete channel sections, grates, and appurtenances; designed so grates fit into channel recesses without rocking or rattling. Include the quantity of units required to form total lengths indicated.
  - b. Basis-of-Design Product: Subject to compliance with requirements, indicated on drawings or comparable products.
  - c. Wide-Width, Level-Invert, Polymer-Concrete Systems:
    - 1) Channel Sections:
      - a) Interlocking-joint, pre-cast, modular units with end caps.
      - b) Dimensions of the inside width and deep as specified on the details, rounded bottom, with level invert and with outlets in quantities, sizes, and locations indicated.
    - 2) Grates:



- a) Slots or other openings that fit recesses in channels that meet ADA requirements.
  - b) Material: Gray iron.
  - d. Covers: Solid gray iron, if indicated.
  - e. Locking Mechanism: Manufacturer's standard device for securing grates to channel sections.
6. DRAINAGE SPECIALTIES: PRE-CAST, POLYMER-CONCRETE UNITS.
- a. Large Catch Basins:
  - b. 24-by-12-inch polymer-concrete body, with outlets in quantities and sizes, indicated.
  - c. Gray-iron slotted grate that meets ADA requirements.
  - d. Frame: Include gray-iron or steel frame for grate.
  - e. Supports, Anchors, and Setting Devices: Manufacturer's standard unless otherwise indicated.
  - f. Channel-Section Joining and Fastening Materials: As recommended by the system manufacturer.
7. STORMWATER QUALITY DEVICES
- a. Stormwater quality devices shall be pre-manufactured systems designed to remove settleable and floating pollutants in stormwater. The contractor shall supply shop drawings for review and approval prior to installation. Drawings shall include dimensions, elevations, and configuration of the chambers, including any internal flow controls; attenuation channels, weirs, baffles, orifices, and overflow devices. Stormwater quality chambers shall be designed for these flow applications with the complete high-level bypass in case of clogging. These units shall be constructed of reinforced concrete with full manhole access and according to ASTM C890 for HS-20 traffic loads.
  - b. Frames and Covers: Gray Iron Casting, ASTM – A 48/ A 48M-03, class 30B, suitable for AASHTO HS20-44 Highway Loading. Finish: bearing surface for frame & cover machined. The cover should be label “STORM DRAIN”.
  - c. For bedding use ¾” clean crushed stone conforming to the requirements of Section M.01.for No.6 stone of the State of Connecticut Department of Transportation “Standard Specifications for Roads, Bridges and Incidental Construction”, Form 817, including July 2019 supplemental and edition.
8. SUBSURFACE STORMWATER RETENTION/ DETENTION SYSTEM
- a. Structures
    - 1) All precast concrete structures and components shall be manufactured in accordance with the approved design shop drawings.

- 2) The contractor shall supply shop drawings for review and approval prior to installation. Drawings shall include dimensions, elevations, and configuration of the system, including any internal flow controls; attenuation channels, weirs, baffles, orifices and overflow devices. They shall also include inlet splash pads, sumps and outlet control structures. The drawings shall identify and detail all roof access openings and inlet/outlet pipe openings.
  - b. Precast Concrete
    - 1) Precast concrete shall be manufactured by an NPCA certified plant.
    - 2) Precast vendor shall submit structural calculations prepared by a licensed Professional Engineer licensed in the state of installation.
    - 3) Precast concrete shall be a minimum of 5000psi @ 28 days.
    - 4) Reinforcing shall conform to the latest ASTM A615.
    - 5) The design shall conform to H-20 Loading conditions per AASHTO HS-20-44.
    - 6) Precast vendor shall supply sufficient lifting devices cast into the structures capable of supporting structure.
  - c. Structural Design
    - 1) Soil strength shall be verified to be a minimum of 3000 psf soil bearing capacity. The soil density is assumed to be 120 PCF.
    - 2) Subgrade soils shall be compacted to a 95% density.
9. CONCRETE
- a. General: Cast-in-place concrete according to ACI 318, ACI 350R, and the following:
    - 1) Cement: ASTM C 150, Type II.
    - 2) Fine Aggregate: ASTM C 33, sand.
    - 3) Coarse Aggregate: ASTM C 33, crushed gravel.
    - 4) Water: Potable.
  - b. Portland Cement Design Mix: Class C or F 4500 psi minimum, with 0.45 maximum water-cementitious ratio.
    - 1) Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
    - 2) Reinforcement Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed steel.
10. RIPRAP
- a. Riprap shall conform to CTDOT Form 817, including July 2019 supplemental, Section M.12.02 in the sizes specified on the drawings.

### PART 3 - EXECUTION

#### 3.1 EARTHWORK

- A. Excavating, trenching, and backfilling are specified in Division 31 Section " Trenching, and Backfilling."

#### 3.2 IDENTIFICATION

- A. Backfill materials are specified in Division 31 Section 312333 " Trenching, and Backfilling."
- B. Arrange for installing green warning detectable tapes directly over piping and at outside edges of underground structures.
  - 1. Green with black letters and imprinted with "CAUTION BURIED STORM DRAIN LINE BELOW".
  - 2. Use detectable warning tape over ferrous piping.
  - 3. Use detectable warning tape over nonferrous piping and over edges of underground structures.

#### 3.3 INSTALLATION, GENERAL

- A. General Locations and Arrangements: Drawing plans and details indicate the general location and arrangement of underground storm drainage piping. The location and arrangement of the piping layout take design considerations into account. Install piping as indicated, to the extent practical.
- B. Install piping beginning at a low point, true to grades and alignment indicated with an unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cement, and other installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.
- C. Use manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into an existing storm sewer is indicated.
- D. Use proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing the size of piping in the direction of flow is prohibited.
- E. Install gravity-flow piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

- F. Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent, unless otherwise indicated.
- G. Extend storm drainage piping and connect to building's storm drains, of sizes and in locations indicated. Terminate piping as indicated.

### 3.4 PIPE JOINT CONSTRUCTION AND INSTALLATION

- A. General: Join and install pipe and fittings according to installations indicated.
- B. PVC Sewer Pipe and Fittings: As follows:
  - 1. Join pipe and gasketed fittings with gaskets according to ASTM D 2321.
  - 2. Install according to ASTM D 2321.
- C. HDPE Pipe fittings:
  - 1. Fittings shall conform to AASHTO M252, AASHTO M294 or ASTM F2306. Bell and spigot connections shall utilize a spun-on or welded bell and valley or saddle gasket meeting the soil tight joint performance requirements of AASHTO M252, AASHTO M294 or ASTM F2306.
  - 2. Field Pipe and Joint Performance: To assure soil tightness, field performance verification may be accomplished by testing in accordance with ASTM F248. Appropriate safety precautions must be used when field testing any pipe material. Contact the manufacturer for recommended leakage rates.
- D. Join piping made of different materials or dimensions with couplings made for this application. Use couplings that are compatible with and that fit both systems' materials and dimensions.

### 3.5 MANHOLE INSTALLATION

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Set tops of frames and covers flush with the finished surface of manholes that occur in pavements. Set tops 3 inches above finished surface elsewhere, unless otherwise indicated.
- C. Install pre-cast concrete manhole sections with gaskets according to ASTM C 891.

### 3.6 CATCH BASIN, STORMWATER YARD DRAIN, STORMWATER CLEANOUT, AND TRENCH DRAIN INSTALLATION

- A. Construct catch basins, stormwater yard drains, cleanout, and slot drain to sizes and shapes indicated.

- B. Set frames and grates to elevations indicated.

### 3.7 CONCRETE PLACEMENT

- A. Place cast-in-place concrete according to ACI 318 and ACI 350R.

### 3.8 SUBSURFACE RETENTION/DETENTION SYSTEM, WATER QUALITY DEVICES, AND DISCHARGE CHAMBER

- A. Installation shall be in accordance with the approved engineering drawings, specifications, and calculations. Location, dimensions, elevations, pipe sizes, and access manholes shall be per plan.
- B. Construct system to sizes and shapes indicated on the plans and details.
- C. Set frames and grates to elevations indicated.
- D. The contractor shall excavate the installation area to the specified sub-grade elevation. Sub-grade soils shall be graded to a consistent level bed, free from deleterious materials such as organics, trash, and debris. Sub-grades shall be compacted to a 95% density.
- E. For detention/retention systems, the contractor shall place a non-woven geotextile fabric pads over the complete base and sides of the excavation walls. Fabric pads shall be wrapped so as to contain the required crushed stone base section specified and to isolate the exterior perimeter of the structures from the native material backfill. Fabric shall be wrapped over the top of the retention/detention system structures a minimum of 4'. Fabric shall be installed in such fashion so as to create a wrap whereas the corner folds overlap and are folding into an upward position to keep fabric materials in place during excavation and backfill operations.
- F. A minimum of 6" of ¾"+ crushed stone base placed in a 95% compacted level grade shall be installed on top of the filter fabric in the bottom of the excavation.
- G. Precast concrete (or cast in place) inlet splash pads shall be installed to the specified grade and locations per plan.
- H. The chamber shall be installed in a level and plumb fashion so as to minimize the gap between structures to no more than an average of ¼" and no greater than ½" gap. Unless noted, all structure bottom and top elevations shall be equal to within ½".
- I. Exterior top joints shall be sealed with ribbon tape. "Ribbon tape" shall be applied to a clean dry surface that may require surface preparation to apply per the manufacture's

recommendations. "Ribbon tape" shall be applied in a continuous length; although when required, a minimum of a 12" overlay can be utilized.

- J. All pipe inverts shall be installed per specified elevation. Installation of the inlet/outlet pipes with a membrane system shall incorporate a watertight rubber boot and flange gasket kit supplied by the vender. The rubber boot shall be installed inside the pipe hole cut into the structure wall. The hole shall be clean and smooth and free of loose or foreign material. The rubber boot should fit tightly and snug against the receiving concrete wall section. The internal metal expansion ring should be tightened to the manufacturers recommended torque. The pipe should be slipped into the rubber boot and the external metal pipe clamp should be tightened down to the manufacturer's recommended torque. When using a corrugated pipe, a pipe adapter may be supplied by the pipe vendor to fill the cavity and produce a flat surface to connect the pipe boot to. Those materials may be a "rope tar" or "ribbon tape" material or a watertight caulking construction sealant.
- K. For infiltration systems a masonry grout filled pipe hole is sufficient.
- L. For internal piping configurations, a rubber boot system or masonry grout filled pipe hole is sufficient.
- M. The internal flow control structure shall be installed per plan specifications.
- N. The contractor shall install manhole access structures per plan specifications.
- O. Backfill around and on top of structures shall consist of select native material, structural fill or structural stone per plan specifications. Fills shall be placed in 9" lifts at 95% compaction. All fill should not contain any deleterious materials or stones larger than 3" diameter within 6" of system top.

### 3.9 FIELD QUALITY CONTROL

- A. Clear interior of piping and structures of dirt and superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed.
  - 1. In large, accessible piping, brushes and brooms may be used for cleaning.
  - 2. Place plug-in end of incomplete piping at end of day and when work stops.
  - 3. Flush piping between manholes and other structures to remove collected debris, if required by authorities having jurisdiction.
- B. Inspect the interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at the completion of the Project.
  - 1. Submit separate reports for each system inspection.

2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of the inside of the pipe is visible between structures.
    - b. Deflection: Flexible piping with a deflection that prevents the passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Crushed, broken, cracked, or otherwise damaged piping.
    - d. Infiltration: Water leakage into piping.
    - e. Exfiltration: Water leakage from or around piping.
  3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
  4. Re-inspect and repeat the procedure until the results are satisfactory.
- C. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects:
1. Do not enclose, cover, or put into service before inspection and approval.
  2. Test completed piping systems according to authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  4. Submit separate reports for each test.
  5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
    - a. Exception: Piping with soil tight joints unless required by authorities having jurisdiction.
    - b. Option: Test plastic piping according to ASTM F 1417.
    - c. Option: Test concrete piping according to ASTM C 924
  6. Leaks and loss in test pressure constitute defects that must be repaired.
  7. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

### 3.10 CLEANING

- A. Clean the interior of the piping of dirt and superfluous materials. Flush with water.

### 3.11 AS-BUILT

- A. Provide an As-Built drawing of all constructed items locations and elevations A-2/T-2 accuracy prepared by a Licensed Land Surveyor licensed in Connecticut. Provide a statement that the as-built record conforms with the design, or as acceptable by the design engineer. As-built to be prepared in a paper, Mylar and AutoCAD format and provided to the Owner.

- B. After construction is completed, the Professional Engineer that is licensed in CT. who supervised the installation of the Underground stormwater retention/detention system on the site is to submit a written certification that the system was installed as per the approved design.

END OF SECTION 334000



SECTION 337119 - ELECTRICAL UNDERGROUND DUCTS AND HANDHOLES

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes:
  - 1. Rigid steel conduit.
  - 2. Plastic conduit.
  - 3. Plastic duct.
  - 4. Reinforced resin conduit.
  - 5. Precast concrete manholes.
  - 6. Handholes.
  - 7. Underground duct markers.
  - 8. Cast-in-place manhole accessories.
  
- B. Related Sections:
  - 1. See Division 31 - Excavation: Product and execution requirements for excavation and backfill required by this section.
  - 2. See Division 31 - Fill: Requirements for backfill to be placed by this section.
  - 3. See Division 31 - Trenching: Execution requirements for trenching required by this section.

1.2 REFERENCES

- A. American National Standards Institute:
  - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc Coated.
  
- B. ASTM International:
  - 1. ASTM A48/A48M - Standard Specification for Gray Iron Castings.
  - 2. ASTM C857 - Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
  - 3. ASTM C858 - Standard Specification for Underground Precast Concrete Utility Structures.
  - 4. ASTM C891 - Standard Practice for Installation of Underground Precast Concrete Utility Structures.
  - 5. ASTM C1037 - Standard Practice for Inspection of Underground Precast Concrete Utility Structures.
  
- C. Institute of Electrical and Electronics Engineers:
  - 1. IEEE C2 - National Electrical Safety Code.

- D. National Electrical Manufacturers Association:
  - 1. NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit and Cable Assemblies.
  - 2. NEMA TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
  - 3. NEMA TC 3 - PVC Fittings for Use with Rigid PVC Conduit and Tubing.
  - 4. NEMA TC 6 - PVC and ABS Plastic Utilities Duct for Underground Installation.
  - 5. NEMA TC 9 - Fittings for ABS and PVC Plastic Utilities Duct for Underground Installation.
  - 6. NEMA TC 10 - PVC and ABS Plastic Communications Duct for Underground Installation.
  - 7. NEMA TC 14 - Filament Wound Reinforced Thermosetting Resin Conduit and Fittings.
  
- E. Underwriters Laboratories Inc.:
  - 1. UL 651A - Type EB and A Rigid PVC Conduit and HDPE Conduit.

### 1.3 SYSTEM DESCRIPTION

- A. Interconnected system of conduits, ducts, manholes and handholes to distribute medium-voltage power, telephone, data communications, exterior feeder wiring, exterior branch circuit wiring, and exterior lighting branch circuit wiring.
  
- B. Conduit and duct routing and handhole locations are shown in approximate locations unless dimensions are indicated. Route and locate to complete duct bank system.
  
- C. Ducts and conduits routed for future use shall be terminated 5'-0" from the building foundation line. All ducts terminated in this fashion shall be capped and provided with nylon drag lines
  
- D. Medium-voltage: Comply with Utility Company requirements for primary service ducts and conduits.
  
- E. Exterior branch circuit and lighting: Use rigid plastic underground conduit. Provide rigid steel conduit sweeps up into bases and structures.
  
- F. Telephone: Comply with Utility Company requirements for primary service ducts and conduits.

### 1.4 SUBMITTALS

- A. See Division 01 – General Requirements.
  
- B. Product Data: Submit for metallic conduit, nonmetallic conduit, ducts, and handholes.
  
- C. Manufacturer's Installation Instructions: Submit application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

1.5 SUSTAINABLE DESIGN SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Manufacturer's Certificate: Certify products meet or exceed specified sustainable design requirements.
  - 1. Materials Resources Certificates:
    - a. Certify source and origin for salvaged and reused products.
    - b. Certify recycled material content for recycled content products.
    - c. Certify source for local and regional materials and distance from Project site.
- C. Product Cost Data: Submit cost of products to verify compliance with Project sustainable design requirements. Exclude cost of labor and equipment to install products.
  - 1. Provide cost data for the following products:
    - a. Salvaged products.
    - b. Reused products.
    - c. Products with recycled material content.
    - d. Local and regional products.

1.6 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Project Record Documents: Record actual routing and elevations of underground conduit and duct, and locations and sizes of handholes.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

1.8 COORDINATION

- A. See Division 01 – General Requirements.
- B. Coordinate Work with existing underground utilities and structures.

PART 2 PRODUCTS

2.1 RIGID STEEL CONDUIT

- A. Manufacturers:
  - 1. Allied Tube and Conduit.
  - 2. Western Tube and Conduit.
  - 3. Wheatland Tube Company.
  - 4. Substitutions: See Division 01 - General Requirements.

- B. Rigid Steel Conduit: ANSI C80.1.
- C. Rigid Aluminum Conduit: ANSI C80.5.
- D. Fittings and Conduit Bodies: NEMA FB 1; material to match conduit.

## 2.2 PLASTIC CONDUIT

- A. Manufacturers:
  - 1. Carlon Electrical Products.
  - 2. Thomas & Betts Corp.
  - 3. Allied Tube and Conduit.
  - 4. Substitutions: See Division 01 - General Requirements.
- B. Fittings and Conduit Bodies: NEMA TC 3.
- C. Rigid Plastic Conduit: NEMA TC 2, Schedule 40/80 PVC, with fittings and conduit bodies to NEMA TC 3.

## 2.3 HANDHOLES

- A. In-Ground Handholes: Stackable, open bottom as manufactured by Qauzite Co. (size as indicated on drawings):
  - 1. Material: Precast concrete.
  - 2. Cover: Traffic rated precast concrete.
  - 3. Cover Legend: "ELECTRIC" or "TELECOMMUNICATIONS".
  - 4. Provide size as required for primary electrical and telco circuits.
- B. Description: Molded composite handhole comprising modular, interlocking sections complete with accessories.
- C. Loading: ASTM C857, Class A-16.
- D. Covers: Molded composite with tamperproof "Penta Head" fasteners. Furnish cover marked to indicate utility.
- E. Provide (5) tools for removal of tamperproof fasteners, including all required sizes.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. See Division 01 – General Requirements.
- B. Verify routing and termination locations of duct bank prior to excavation for rough-in.
- C. Verify locations of handholes prior to excavating for installation.

3.2 INSTALLATION

- A. Install Work in accordance with the requirements of the Town of Watertown and the State of Connecticut DOT Standards.

3.3 INSTALLATION - DUCT BANK

- A. Install duct to locate top of ducts at depths as indicated on Drawings.
- B. Install conduit and duct with minimum slope of 4 inches per 100 feet (0.33 percent). Slope conduit and duct toward manholes and away from building entrances.
- C. Cut conduit and duct square using saw or pipe cutter; de-burr cut ends.
- D. Insert conduit and duct to shoulder of fittings; fasten securely.
- E. Join nonmetallic conduit and duct using adhesive as recommended by manufacturer.
- F. Wipe nonmetallic conduit and duct dry and clean before joining. Apply full even coat of adhesive to entire area inserted in fitting. Allow joint to cure for 20 minutes, minimum.
- G. Install no more than equivalent of three 90-degree bends between pull points.
- H. Install fittings to accommodate expansion and deflection.
- I. Terminate conduit and duct at manhole entries using end bell.
- J. Cross line voltage and low voltage, telecommunications conduits perpendicular to each other.
- K. Maintain the following horizontal and vertical separation where not indicated on the drawings:
  - 1. 3" between outside edges of conduits for like systems.
  - 2. 12" between outside edges of low voltage, telecommunications conduits and line voltage conduits.
- L. Use suitable separators and chairs installed not greater than 4 feet on centers. Secure separators and chairs to trench bottom prior to concrete pour or backfill.
- M. Band conduits and ducts together before backfilling.
- N. Securely anchor conduit and duct to prevent movement.
- O. Provide suitable pull string in each empty duct except sleeves and nipples.
- P. Swab duct. Use suitable caps to protect installed duct against entrance of dirt and moisture.
- Q. Backfill trenches in accordance with Division 31.

3.4 INSTALLATION - PRE-CAST HANDHOLE

- A. Excavate for handhole installation in accordance with Division 31.
- B. Install and seal precast sections in accordance with ASTM C891.
- C. Install handholes plumb.
- D. Backfill handhole excavation in accordance with Division 31.

END OF SECTION 337119

## SECTION 337900 - SITE GROUNDING

### PART 1 GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Rod electrodes.
  - 2. Active electrodes.
  - 3. Exothermic connections.
  - 4. Mechanical connectors.
  - 5. Wire.

#### 1.2 REFERENCES

- A. Institute of Electrical and Electronics Engineers:
  - 1. IEEE 142 - Recommended Practice for Grounding of Industrial and Commercial Power Systems.
  - 2. IEEE C2 - National Electrical Safety Code.
- B. International Electrical Testing Association:
  - 1. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems.

#### 1.3 SYSTEM DESCRIPTION

- A. Rod electrodes for local grounding at utility transformer, generator and exterior metallic poles.

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Overall Resistance to Ground: 25 ohms.

#### 1.5 SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Shop Drawings: Indicate layout and installation details of grounding components.
- C. Product Data: Submit data for grounding electrodes and connectors.
- D. Test Reports: Indicate overall resistance to ground.

#### 1.6 CLOSEOUT SUBMITTALS

- A. See Division 01 – General Requirements.
- B. Project Record Documents: Record actual locations of electrodes and connections.

## 1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years documented experience.

## PART 2 PRODUCTS

### 2.1 ROD ELECTRODES

- A. Manufacturers:
  - 1. Copperweld, Inc.
  - 2. Erico, Inc.
  - 3. O-Z Gedney Co.
  - 4. Thomas & Betts, Electrical
  - 5. Substitutions: Section 01 60 00 - Product Requirements.
- B. Product Description:
  - 1. Material: Copper-clad steel.
  - 2. Diameter: 3/4 inch.
  - 3. Length: 10 feet.
- C. Connector: Connector for exothermic welded connection.

### 2.2 EXOTHERMIC CONNECTIONS

- A. Manufacturers:
  - 1. Cadweld, Erico, Inc.
  - 2. Copperweld, Inc.
  - 3. ILSCO Corporation.
  - 4. O-Z Gedney Co.
  - 5. Thomas & Betts, Electrical.
  - 6. Substitutions: See Division 01 - General Requirements.
- B. Product Description: Exothermic materials, accessories, and tools for preparing and making permanent field connections between grounding system components.

### 2.3 MECHANICAL CONNECTORS

- A. Manufacturers:
  - 1. Copperweld, Inc.
  - 2. Erico, Inc.
  - 3. ILSCO Corporation
  - 4. O-Z Gedney Co.
  - 5. Thomas & Betts, Electrical.
  - 6. Substitutions: See Division 01 - General Requirements.
- B. Description: Bronze connectors, suitable for grounding and bonding applications, in configurations required for particular installation.



2.4 WIRE

- A. Material: Stranded copper.
- B. Horizontal Electrodes: 4/0 AWG, minimum size.
- C. Connections to Electrodes: 2/0 AWG, minimum size.
- D. Bonding Other Objects: 2 AWG, minimum size.
- E. Mechanical Connector: Bronze.
- F. Grounding Boxes: Bronze.

PART 3 EXECUTION

3.1 EXAMINATION

- A. See Division 01 – General Requirements.
- B. Verify final backfill and compaction has been completed before driving rod electrodes.

3.2 INSTALLATION

- A. Install rod electrodes in vertical position with bottom at least 5 feet below frost line.
- B. Install interconnecting wire 2 feet below frost line.
- C. Provide chemical treatment at each vertical electrode site.
  - 1. Saturate treatment chemicals with water following application.
  - 2. Dig circular trench centered on electrode. Make trench 12 inches deep with 18 inch inside diameter. Uniformly distribute 50 lb of treatment material in bottom of trench and cover with topsoil.

3.3 FIELD QUALITY CONTROL

- A. See Division 01 – General Requirements.
- B. Inspect and test in accordance with NETA ATS, except Section 4.
- C. Perform inspections and tests listed in NETA ATS, Section 7.13. Make final grounding system measurements three or four days after chemical treatment.

3.4 DEMONSTRATION

- A. See Division 01 – General Requirements.
- B. Demonstrate location of each accessible grounding connection and each chemical treatment well.

END OF SECTION 337900

# **Section 50 20 00 Environmental Assessment Information**



SECTION 502000 – PROJECT SPECIFIC ADDITIONAL INFORMATION: NATURAL DIVERSITY DATABASE

PART 1 - GENERAL

1.1 SUMMARY

- A. Connecticut Department of Energy & Environmental Protection performed a review of the Natural Diversity Data Base maps and files regarding the proposed project and based on their information there are known extant populations of State Threatened northern spring salamander (*Gyrinophilus porphyriticus*) and State Special Concern wood turtle (*Glyptemys insculpta*), smooth green snake (*Opheodrys vernalis*) and hairy-fruited sedge (*Carex trichocarpa*) in the project area. The review was summarized in a letter dated February 23, 2019, from Dawn M. McKay, Environmental Analyst 3, Project: Construction of a New LEED DEEP Western District Headquarters with Two Parking Areas at 2065 Thomaston Road, Watertown, Connecticut. NDDB Determination No.: 201813885. This NDDB request must be resubmitted if the scope of work changes or if work has not begun on this project by February 23, 2021.

1.2 ABBREVIATIONS

- A. CTDEEP: Connecticut Department of Energy & Environmental Protection
- B. NDDB: Natural Diversity Data Base

1.3 CTDEEP RECOMMENDED PROTECTION STRATEGIES FROM February 23, 2019 letter referenced above

- A. The contractor shall receive written permission from the Architect or Owner in order to deviate from any of the below noted recommended protection strategies.
- B. NORTHERN SPRING SALAMANDER: This State Threatened Species requires cold, clean, well-oxygenated springs, brooks or seepage areas. Their favored habitat is heavily forested steep rocky ravines. Any activities that decreased the forest canopy would increase the water temperature and this species definitely requires cold water.
  - 1. Recommended Protection Strategies for Northern Spring Salamander:
    - a. Keep equipment and project activities out of the stream all together. If work must be conducted in or around the stream, I will require you to hire a herpetologist to do an assessment of the stream and provide a protection and/or conservation plan to keep this State Threatened salamander safe.

- b. Trees should not be removed adjacent to any stream or brook.
  - c. A buffer of at least 100 feet along watercourses should be maintained to minimize any temperature or microclimate change of the riparian areas within this forest.
  - d. Hiring a qualified herpetologist to be on site to ensure these protection guidelines remain in effect and prevent salamanders from being killed when moving heavy equipment. This is especially important because these salamanders remain active all year.
- C. WOOD TURTLE: Habitat destruction, degradation or alteration and fragmentation all threaten wood turtle populations. Turtles are also particularly vulnerable to any activity that consistently reduces adult survivorship. Individuals of this species are riverine and riparian obligates, overwintering and mating in clear, cold, primarily sand-gravel and rock bottomed streams and foraging in riparian zones, fields and upland forests during the late spring and summer. They hibernate in the banks of the river in submerged tree roots between November 1 and April 1. Their summer habitat focuses within 90m (300ft of rivers) and they regularly travel 300m (0.2 mile) from rivers during this time. During summer they seek out early successional habitat: pastures, old fields, woodlands, powerline cuts and railroad beds bordering or adjacent to streams and rivers. Their habitat in Connecticut is already severely threatened by fragmentation of riverine, instream, riparian, and upland habitats, but is exacerbated by heavy adult mortality from machinery, cars, and collection. This is compounded by the species late maturity, low reproductive potential, and high nest and hatchling depredation rates.

The following protection measures will help minimize risk to turtles:

Land disturbance activities that involve vehicle traffic or heavy equipment that can crush adult turtles need to consider local habitat features and apply fencing during sensitive times of year.

Disturbances to stream and riparian habitats and activities that change the hydrology of the stream, the physical habitat itself and water quality are all potentially detrimental activities for the wood turtle. Although wood turtles are found within forested areas, they prefer areas that do not have a fully closed canopy cover. Wood turtles congregate and eventually overwinter in streams under tangled tree roots. Care should be taken not to drag tree tops or remove tree stumps that may occur on streambanks. The greatest concern during projects occurring in wood turtle habitat are turtles being run over and crushed by mechanized equipment. Reducing the frequency that motorized vehicles enter wood turtle habitat would be beneficial in minimizing direct mortality of adults.

- 1. Recommended Protection Strategies for Wood Turtle:
  - a. Hiring a qualified herpetologist to be on site to ensure these protection guidelines remain in effect and prevent turtles from being run over when moving heavy equipment. This is especially important in the months of May, June and July when turtles are selecting nesting sites.

Between April 1- November 1:

- b. Exclusionary practices should be used to prevent any turtle access into heavy equipment use and staging areas. These measures will need to be installed at the limits of disturbance as shown on the plans.

- c. Exclusionary practices will be required to prevent any turtle access into construction areas. These measures will need to be installed at the limits of disturbance.
  - d. Exclusionary fencing must be at least 20 in tall and must be secured to and remain in contact with the ground and be regularly maintained (at least bi-weekly and after major weather events) to secure any gaps or openings at ground level that may let animal pass through. Do not use plastic or netted silt-fence.
  - e. All staging and storage areas, outside of previously paved locations, regardless of the duration of time they will be utilized, must be reviewed to remove individuals and exclude them from re-entry.
  - f. All construction personnel working within the turtle habitat must be apprised of the species description and the possible presence of a listed species, and instructed to relocate turtles found inside work areas or notify the appropriate authorities to relocate individuals.
  - g. Any turtles encountered within the immediate work area shall be carefully moved to an adjacent area outside of the excluded area and fencing should be inspected to identify and remove access point. This animal is protected by law and should not be relocated off-site.
  - h. In areas where silt fence is used for exclusion, it shall be removed as soon as the area is stable to allow for reptile and amphibian passage to resume.
  - i. No heavy machinery or vehicles may be parked in any turtle habitat.
  - j. Special precautions must be taken to avoid degradation of wetland habitats including any wet meadows and seasonal pools.
  - k. The Contractor and consulting herpetologist must search the work area each morning prior to any work being done.
  - l. When felling trees adjacent to brooks and streams please cut them to fall away from the waterway and do not drag trees across the waterway or remove stumps from banks.
  - m. Avoid and limit any equipment use within 50 feet of streams and brooks.
  - n. Any confirmed sightings of box, wood or spotted turtles should be reported and documented with the NDDDB ([nddbrequestdep@ct.gov](mailto:nddbrequestdep@ct.gov)) on the appropriate special animal form found at ([http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323460&depNav\\_GID=1641](http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323460&depNav_GID=1641))
  - o. In areas where silt fence is used for exclusion, it shall be removed as soon as the area is stable and disturbance is finished to allow for reptile and amphibian passage to resume.
- D. SMOOTH GREEN SNAKE: The smooth green snake favors meadows and grassy fields often along forest edges where their coloration can camouflage them. This species is dormant from 1st of November to April 15th. It has been negatively impacted by the loss of suitable habitat.
- 1. Recommended Protection Strategies for Smooth Green Snake: If work or staging of equipment must be done during the smooth green snake active period (April 1st to November 1st) the following precautionary measures be implemented to protect them:
    - a. The workers be apprised of the species description and possible presence and that the area be searched each day prior to construction.
    - b. Any snakes encountered during the work be moved out of the way, just outside the work area.

- c. Vehicles and heavy machinery should operate at slower speeds to allow animals the time to move out of harm's way on their own.
- d. Work conducted in these habitats (grassy fields) during the early morning and evening hours should occur with special care not to harm basking or foraging individuals.
- e. No heavy machinery or vehicles be parked in any snake habitat (grassy fields).

E. HAIRY-FRUITED SEDGE:

- 1. Habitat: Marshes and wet meadows.
- 2. Blooms: June through July.
- 3. Recommended Protection Strategies for Hairy-fruited Sedge: State Special Concern hairy-fruited sedge is a wetland plant that occurs in marshes and wet meadows. If any wetland or stream disturbance is required, a botanical site survey will be required to assess whether there will be adverse impacts on this plant species.

Standard protocols for protection of wetlands should be followed and maintained during the course of the project. Additionally, all silt fencing should be removed after soils are stable so that reptile and amphibian movement between uplands and wetlands is not restricted.

END OF SECTION 502000



March 24, 2020

Rima Lukaitis  
Martinez Couch & Associates LLC  
1084 Cromwell Ave, Suite A-2  
Rocky Hill, CT 06067  
[rlauk@martinezcouch.com](mailto:rlauk@martinezcouch.com)

**NDDB DETERMINATION NUMBER:** 202000567, associated with 201813885

**Project:** Directional Drilling underneath Branch Brook associated with Determination 201813885: Construction of new CT DEEP West District Headquarters and facilities at Black Rock State Park; 2065 Thomaston Rd. in Watertown and 422 Watertown Road in Thomaston, CT

**Expiration:** March 24, 2022

I have reviewed Natural Diversity Data Base (NDDB) maps and files regarding this project. According to our records, there are State-listed species (RCSA Sec. 26-306) documented nearby and may wander into your work areas. Guidance to avoid impact is provided below. Continue to refer to guidance in determination 201813885 (attached) for other aspects of your project.

#### **Wood turtle (*Glyptemys insculpta*)- State Special Concern**

Individuals of this species are riverine and riparian obligates, overwintering and mating in clear, cold, primarily sand-gravel and rock bottomed streams and foraging in riparian zones, fields and upland forests during the late spring and summer. They hibernate in the banks of the river in submerged tree roots between November 1 and April 1. Their summer habitat focuses within 90m (300ft of rivers) and they regularly travel 300m (0.2 mile) from rivers during this time. During summer they seek out early successional habitat: pastures, old fields, woodlands, powerline cuts and railroad beds bordering or adjacent to streams and rivers. Their habitat in Connecticut is already severely threatened by fragmentation of riverine, instream, riparian, and upland habitats, but is exacerbated by heavy adult mortality from machinery, cars, and collection. This is compounded by the species late maturity, low reproductive potential, and high nest and hatchling depredation rates.

The following protection measures will help minimize risk to turtles:

Land disturbance activities that involve vehicle traffic or heavy equipment that can crush adult turtles need to consider local habitat features and apply fencing during sensitive times of year.

Between April 1- November 1:

- Exclusionary practices should be used to prevent any turtle access into heavy equipment use and staging areas. These measures will need to be installed at the limits of disturbance as shown on the plans.
- Exclusionary fencing should be at least 20 in tall and must be secured to and remain in contact with the ground and be regularly maintained (at least bi-weekly and after major weather events) to secure any gaps or openings at ground level that may let animal pass through.
- All construction personnel working must be apprised of the species description and the possible presence of a listed species.

- Any turtles or snakes encountered within the immediate work area shall be carefully moved to an adjacent area outside of the excluded area and fencing should be inspected to identify and remove access point. This animal is protected by law and should not be relocated off-site.
- In areas where silt fence is used for exclusion, it shall be removed as soon as the area is stable and disturbance is finished to allow for reptile and amphibian passage to resume.

Please submit an updated NDDDB Request for Review if the scope of the proposed work changes.

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Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Department of Energy and Environmental Protection's Bureau of Natural Resources and cooperating units of DEEP, independent conservation groups, and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the NDDDB should not be substituted for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated in the NDDDB as it becomes available.

Please contact me if you have any questions ([shannon.kearney@ct.gov](mailto:shannon.kearney@ct.gov)). Thank you for consulting with the Natural Diversity Data Base and continuing to work with us to protect State-listed species.

Sincerely,

/s/ Shannon B. Kearney  
Wildlife Biologist



Connecticut Department of  
**ENERGY &  
ENVIRONMENTAL  
PROTECTION**

February 23, 2019

Ms. Kati L. Mercier  
Martinez Couch & Associates, LLC  
1084 Cromwell Avenue  
Rocky Hill, CT 06067  
[kmercier@martinezcouch.com](mailto:kmercier@martinezcouch.com)

Project: Construction of a New LEED DEEP Western District Headquarters with Two Parking Areas at 2065 Thomaston Road, Watertown, Connecticut  
NDDB Determination No.: 201813885

Dear Kati L. Mercier,

I have reviewed Natural Diversity Data Base maps and files regarding the area delineated on the map you provided for the proposed Construction of a New LEED DEEP Western District Headquarters with Two Parking Areas at 2065 Thomaston Road, Watertown, Connecticut.

According to our information we have known extant populations of State Threatened northern spring salamander (*Gyrinophilus porphyriticus*) and State Special Concern wood turtle (*Glyptemys insculpta*), smooth green snake (*Opheodrys vernalis*) and hairy-fruited sedge (*Carex trichocarpa*) in the project area.

**Northern Spring Salamander:** This State Threatened Species requires cold, clean, well-oxygenated springs, brooks or seepage areas. Their favored habitat is heavily forested steep rocky ravines. Any activities that decreased the forest canopy would increase the water temperature and this species definitely requires cold water.

**Recommended Protection Strategies for Northern Spring Salamander:**

- Keep equipment and project activities out of the stream all together. If work must be conducted in or around the stream, I will require you to hire a herpetologist to do an assessment of the stream and provide a protection and/or conservation plan to keep this State Threatened salamander safe.
- Trees should not be removed adjacent to any stream or brook.
- A buffer of at least 100 feet along watercourses should be maintained to minimize any temperature or microclimate change of the riparian areas within this forest.
- Hiring a qualified herpetologist to be on site to ensure these protection guidelines remain in effect and prevent salamanders from being killed when moving heavy equipment. This is especially important because these salamanders remain active all year.

**Wood Turtle:** Habitat destruction, degradation or alteration and fragmentation all threaten wood turtle populations. Turtles are also particularly vulnerable to any activity that consistently reduces adult survivorship. Disturbances to stream and riparian habitats and activities that change the hydrology of the stream, the physical habitat itself and water quality are all potentially detrimental activities for the wood turtle. Although wood turtles are found within forested areas, they prefer areas that do not have a fully closed canopy cover. Wood turtles congregate and eventually overwinter in streams under tangled tree roots. Care should be taken not to drag tree tops or remove tree stumps that may occur on streambanks. The greatest concern during projects occurring in wood turtle habitat are turtles being run over and

crushed by mechanized equipment. Reducing the frequency that motorized vehicles enter wood turtle habitat would be beneficial in minimizing direct mortality of adults.

### **Recommended Protection Strategies for Wood Turtles:**

I recommend these strategies in order to protect these turtles:

- Hiring a qualified herpetologist to be on site to ensure these protection guidelines remain in effect and prevent turtles from being run over when moving heavy equipment. This is especially important in the months of May, June and July when turtles are selecting nesting sites.
- Exclusionary practices will be required to prevent any turtle access into construction areas. These measures will need to be installed at the limits of disturbance.
- Exclusionary fencing must be at least 20 in tall and must be secured to and remain in contact with the ground and be regularly maintained (at least bi-weekly and after major weather events) to secure any gaps or openings at ground level that may let animal pass through. Do not use plastic or netted silt-fence.
- All staging and storage areas, outside of previously paved locations, regardless of the duration of time they will be utilized, must be reviewed to remove individuals and exclude them from re-entry.
- All construction personnel working within the turtle habitat must be apprised of the species description and the possible presence of a listed species, and instructed to relocate turtles found inside work areas or notify the appropriate authorities to relocate individuals.
- Any turtles encountered within the immediate work area shall be carefully moved to an adjacent area outside of the excluded area and fencing should be inspected to identify and remove access point.
- In areas where silt fence is used for exclusion, it shall be removed as soon as the area is stable to allow for reptile and amphibian passage to resume.
- No heavy machinery or vehicles may be parked in any turtle habitat.
- Special precautions must be taken to avoid degradation of wetland habitats including any wet meadows and seasonal pools.
- The Contractor and consulting herpetologist must search the work area each morning prior to any work being done.
- When felling trees adjacent to brooks and streams please cut them to fall away from the waterway and do not drag trees across the waterway or remove stumps from banks.
- Avoid and limit any equipment use within 50 feet of streams and brooks.
- Any confirmed sightings of box, wood or spotted turtles should be reported and documented with the NDDB ([nddbrequestdep@ct.gov](mailto:nddbrequestdep@ct.gov)) on the appropriate special animal form found at ([http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323460&depNav\\_GID=1641](http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323460&depNav_GID=1641))

**Smooth Green Snake:** The smooth green snake favors meadows and grassy fields often along forest edges where their coloration can camouflage them. This species is dormant from 1st of November to April 15<sup>th</sup>. It has been negatively impacted by the loss of suitable habitat.

### **Recommended Protection Strategies for State Listed Snakes:**

If work or staging of equipment must be done during the smooth green snake active period (April 1st to November 1st) the following precautionary measures be implemented to protect them:

- The workers be apprised of the species description and possible presence and that the area be searched each day prior to construction.

- Any snakes encountered during the work be moved out of the way, just outside the work area.
- Vehicles and heavy machinery should operate at slower speeds to allow animals the time to move out of harm's way on their own.
- Work conducted in these habitats (grassy fields) during the early morning and evening hours should occur with special care not to harm basking or foraging individuals.
- No heavy machinery or vehicles be parked in any snake habitat (grassy fields).

***Carex trichocarpa* (Hairy-fruited sedge)**

Habitat: Marshes and wet meadows.

Blooms: June through July.

**Recommended Protection Strategies for Hairy-fruited Sedge**

State Special Concern hairy-fruited sedge is a wetland plant that occurs in marshes and wet meadows. According to your NDDB application, at this time it is unknown whether any wetland or stream disturbance will be required for the potential sanitary line connection. If stream channel or wetland impacts will be included as part of this project, a botanical site survey will be required to assess whether there will be adverse impacts on this plant species.

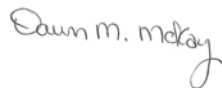
Standard protocols for protection of wetlands should be followed and maintained during the course of the project. Additionally, all silt fencing should be removed after soils are stable so that reptile and amphibian movement between uplands and wetlands is not restricted.

The result of this review does not preclude the possibility that listed species may be encountered on site and that additional action may be necessary to remain in compliance with certain state permits. This determination is good for two years. Please re-submit an NDDB Request for Review if the scope of work changes or if work has not begun on this project by February 23, 2021.

Natural Diversity Data Base information includes all information regarding critical biological resources available to us at the time of the request. This information is a compilation of data collected over the years by the Department of Energy and Environmental Protection's Natural History Survey and cooperating units of DEEP, private conservation groups and the scientific community. This information is not necessarily the result of comprehensive or site-specific field investigations. Consultations with the Data Base should not be substitutes for on-site surveys required for environmental assessments. Current research projects and new contributors continue to identify additional populations of species and locations of habitats of concern, as well as, enhance existing data. Such new information is incorporated into the Data Base as it becomes available.

Please contact me if you have further questions at (860) 424-3592, or [dawn.mckay@ct.gov](mailto:dawn.mckay@ct.gov) . Thank you for consulting the Natural Diversity Data Base.

Sincerely,



Dawn M. McKay  
Environmental Analyst 3

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# **Section 50 40 00 Subsurface Geotechnical Report**





**DEEP West District Headquarters  
At Black Rock State Park  
Watertown, Connecticut**

***Report on  
Geotechnical Engineering Investigation***

**January 21, 2019**

**Prepared By:  
GNCB Consulting Engineers, P.C.  
Old Saybrook, Connecticut**

**Prepared For:  
TLB Architecture, LLC  
Chester, Connecticut**



Consulting Engineers, P.C.

Structural Engineering  
Geotechnical Engineering  
Historic Preservation

January 21, 2019

Michael Fortuna, AIA  
TLB Architecture, LLC  
92 West Main Street  
Chester, Connecticut 06412

Re: Report on Geotechnical Engineering Investigation  
DEEP West District Headquarters at  
Black Rock State Park  
Watertown, Connecticut

Principals  
Charles C. Brown, P.E.  
James F. Norden, P.E.

Principal Emeritus  
Kenneth Gibble, P.E.

Geotechnical Associate  
David L. Freed, P.E.

Structural Associate  
Richard A. Centola, P.E.  
Amy Jagaczewski, P.E.

Dear Mr. Fortuna:

Enclosed is an electronic copy of our geotechnical engineering report that summarizes the results of recent subsurface explorations and foundation design recommendations for the DEEP West District Headquarters at Black Rock State Park in Watertown, Connecticut. Our work was undertaken in accordance with our authorized Contract Agreement dated September 18, 2018.

In summary, the results of 17 test borings and three groundwater observation wells indicate that subsurface conditions at the building area, typically consist of a surface man-placed fill, forest mat/topsoil and subsoil that is underlain by a thick deposit of glacial outwash. We recommend that the proposed building be supported on reinforced concrete spread footings bearing on the naturally-deposited glacial outwash or on compacted structural fill placed on the suitable bearing materials after removing any surface unsuitable soils. The lowest floor slabs may be earth supported. The building will require a perimeter foundation drain adjacent to below grade building walls; under-slab drains are not required. Please refer to the Executive Summary which follows this letter for a summary of our investigations and recommendations.

We appreciate the opportunity to work with you on this aspect of the project. Please call if you have any questions, or if you need additional information.

Sincerely yours,

A handwritten signature in blue ink that reads "David L. Freed". The signature is fluid and cursive, with a long horizontal stroke extending to the right.

David L. Freed, PE  
Geotechnical Associate

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- Previous Test Boring Logs (1982)**

### Appendix B:

- Design Phase Test Boring Logs**

### Appendix C:

- Technical Provisions of Specifications for Compacted Structural Fill**

## EXECUTIVE SUMMARY

### PURPOSE AND SCOPE

This geotechnical engineering study included test borings, groundwater observation wells, investigations, and recommendations for foundation design for a new DEEP West District Headquarters building at Black Rock State Park in Watertown, Connecticut.

### SITE LOCATION AND SURFACE CONDITIONS

The site, which is located at the north end of Black Rock State Park, is located west of Route 6 and south of the park entrance road, in Watertown, Connecticut, as shown on Drawing 1, "Project Locus". Black Rock Pond, with water elevation at about El. 375, is a natural pond that is confined by an earth dam having a top at about El. 380. (Note: Elevations are in feet and refer to NAVD 1988 Datum).

The site is primarily wooded with some open grass areas. Ground surface is approximately level within the upper west area at about El. 396, and within the east lower level at about El. 382; a wooded slope of about 2 hor:1 ver separates the two level areas. The attached Drawings 2 and 2A "Test Boring Plans" show the current site grading.

### PROPOSED CONSTRUCTION

The DEEP building construction consists of a Y-shaped one to two story structure that has a footprint of about 9700 sq. ft. The west upper portion of the building will be one story with a ground floor level at El. 396. The east lower rectangular portion has a lowest floor level ranging from El. 382 at the north end to El. 384 within the south portion. Paved parking areas will be constructed within the upper area south of the building and east of the lower portion of the building. Drawing 2 shows the current

building layout and other site features, along with the current and proposed ground surface grades.

## SUBSURFACE INVESTIGATIONS

In the early 1980s, storm damage to the Black Rock Pond Dam required repairs to the earth embankment. At that time, three test borings (GZ-1 to GZ-3) were drilled; logs of these test borings, are contained in Appendix A.

For the current design of the DEEP structure and associated site amenities, GNCB recommended and monitored a field program consisting of 17 test borings (B-1 to B-17) and three groundwater observation wells; the locations of which are shown on Drawings 2 and 2A. The borings consist of seven (B-1 to B-7) at the building, five borings (B-11 to B-15) at paved parking and access roads, and five (B-8 to B-10, B-16 and B-17) along a possible below ground force main located at the north end of the site.

Table I summarizes the test boring results, Table II is a summary of measured water levels at the observation wells, and logs are contained in Appendix B. The test borings ranged from 12 to 38 ft. and all terminated within the natural deposited glacial outwash soils.

## SUBSURFACE AND GROUNDWATER CONDITIONS

The test borings revealed four soil deposits above bedrock at the building and adjacent paved areas. In general, near surface soils consisted of a man-placed fill, forest mat and/or subsoil, which had a combined thickness of up to 3 ft., underlain by a thick deposit of glacial outwash. The glacial outwash, a naturally deposited soil, consisted of an upper sand and gravel and a lower coarse to fine sand; within the lower elevated east areas, the upper coarser material may be absent. Drawing 2 shows interpolated contours of the top of the glacial outwash deposit within the proposed building area; the

top of this deposit ranges from about El. 396 at the west end, sloping down to as low as El. 375 at the southeast corner. The organic soils encountered at a few borings (B- 8, B- 9 and B-17) is limited to the areas at the north end of the site. Granite bedrock cored at the previous GZ-1 location was encountered at about El. 324.

The Table II water levels suggest a slight downward gradient to the water table from El. 365 to El. 363.

### RECOMMENDATIONS FOR FOUNDATION DESIGN AND CONSTRUCTION

In our opinion, the man-placed fill, forest mat, and subsoil deposits are not suitable to support the building frame and/or ground floor slab. We recommend that the building walls and columns be supported on reinforced concrete spread footings bearing on the natural-deposited glacial outwash, or on compacted structural fill placed on the suitable bearing soils. For foundation design, footings may be sized for a net allowable soil bearing pressure of 5 kips per square feet (ksf). Up to 8 ft. of compacted structural fill is required within the southeast building corner; refer to Drawing 3, "Limits of Compacted Structural Fill Below Footings" which shows the extent of subgrade preparation and fill limits below building footing foundations. Under-slab drains are not required, however as shown on Drawing 4, "Foundation Drain", a perimeter drain is required against all below grade building foundation walls (i.e. along the west side of the two-story building). For seismic design, we recommend a site Soil Class D; the natural inorganic soils and compacted fills to be placed are not susceptible to liquefaction.

### CONSTRUCTION CONSIDERATIONS

The following comments apply to building and site construction:

- Site grading will require removal of up to 3 ft. of existing unsuitable soils within the building area prior to placing compacted structural fill to underside of lowest floor grade. Along the west side of the two-story building, an additional 13 ft. of

the natural glacial outwash deposit will need to be removed to underside of building slab.

- Excavation is anticipated to encounter sand, silt, and gravel; bedrock is not anticipated.
- Compacted fill within building structures should consist of a well-graded sand and gravel. Recommendations for placement of compacted structural fill below buildings are contained in Appendix C.
- The on-site natural glacial outwash soil is likely to satisfy the gradation requirements for compacted structural fill below the building and as common fill below paved and landscape areas.
- Groundwater is not anticipated to be a site factor; temporary dewatering may be needed to keep work areas dry from rain or surface water.
- Footing bearing surface should be recompacted following excavation and prior to placement of reinforcing steel and/or forms.
- During construction, the pertinent foundation related activities, such as placement of compacted fill, excavation for foundations, and preparation of footing and slab bearing surfaces should be monitored by qualified personnel.

**I. PURPOSE AND SCOPE:**

The purpose of this study was to investigate soil, rock, and groundwater conditions at the site and to develop geotechnical engineering recommendations for the DEEP West District Headquarters at Black Rock State Park, 2065 Thompson Road, in Watertown, Connecticut. Comments on geotechnical engineering aspects of project construction are also provided.

To achieve these objectives, GNCB Consulting Engineers, P.C. (GNCB) completed the following scope of work:

- Developed and monitored a program of 17 test borings (B-1 to B-17) and three groundwater observation wells.
- Conducted engineering analyses regarding building foundations, including soil bearing capacity, settlement, seismic requirements, and other aspects of project design.
- Prepared an engineering report that summarizes the work completed.

During our investigation, we worked in close association with the following design team members:

Architect:	TLB Architecture, LLC
Structural Engineer:	GNCB Consulting Engineers, P.C.
Civil Engineer/Surveyor:	Martinez Couch & Associates, LLC
Landscape Architect:	Richter & Cegan, Inc.



## **II. SITE LOCATION AND SURFACE CONDITIONS:**

The project site is located at the north end of Black Rock State Park, west of US Route 6, and south of the park entrance road, as approximately shown on Drawing 1, "Project Locus." Black Rock Pond, which is impounded at its north end by an earth embankment, is located southeast of the site.

The site is mostly wooded, with some cleared open grass fields within the west portion. Ground surface is approximately level within the upper west area at about El. 396 and within the lower southeast area at about El. 377; a wooded sloped of about 2 hor:1 ver separates the two areas. (Note: Elevations are in feet and refer to NAVD 1988 Datum).

## **III. PROPOSED CONSTRUCTION:**

This report accompanies the design team's submittal to the owner of the schematic design.

The DEEP building is a Y-shaped one to two-story structure that has a footprint of about 9700 sq. ft. The west portion of the building will be one story with a ground floor level at EL. 396. The east rectangular portion has lowest floor level ranging from El. 382 at the north end, which services as a vehicle equipment maintenance and shop area, to El. 384 within the south portion. The building is used primarily for administrative and classroom areas. In addition to the building, construction will include two parking areas, a smaller one located within the upper area southeast of the building and a larger one within the lower area east of the building. The attached Drawing 2 shows a current layout of structures and paved areas, as well as existing and proposed site grading.

The building will be a combined steel and wood framed structure with some masonry walls. Interior column loads will generally be less than 125 kips and exterior wall loads less than 3 kips per ft.

Construction will require a significant amount of earthwork operation to establish project grading. For example, within the two-story portion of the building a cut in existing grade of about 13 ft. will be needed within the west portion while a raise in grade of up to 8 ft. will be required within the southeast portion. Also, a raise in grade along the east portion of the lower parking lot will be required; this work will need the support of retaining walls along the east edge of the fill.

#### **IV. SUBSURFACE INVESTIGATIONS:**

##### **A. Previous Test Borings**

In the early 1980s, storm damage and overtopping at the Black Rock Pond required repairs to the earth embankment which impounds the pond. At the time, three test borings (GZ-1 to GZ-3) were drilled to identify the composition of the earth embankment; one of the test borings (GZ-1) cored bedrock. Logs of these previous test borings are contained in Appendix A and the locations, which are about 100 ft. southeast of the building site, are shown on Drawing 2.

##### **B. Design Phase Test Borings and Groundwater Observation Wells**

For project design, GNCB recommended a program of 17 test borings (B-1 through B-17) and three groundwater observation wells (installed at B-3, B-12, and B-13). (Please note that during the schematic design process and after the test borings were drilled, the building shape, size, and location were altered). The borings were completed during the period November 1 to 2, 2018 at the approximate locations shown on Drawings 2 (South Area) and 2A (North Area). GNCB monitored the field work, and estimated ground surface elevations by interpolating the contours shown on the topographic base plan reference on Drawing 2. Prior to starting the field work, Martinez Couch located the explorations in the field by instrument survey. Table I summarizes the subsurface conditions

encountered at each test boring; detailed soil descriptions are contained in the following report section. Logs of the test borings, prepared by the contractor and reviewed by GNCB, are included as Appendix B.

Soiltesting, Inc., Oxford, Connecticut, under contract to GNCB, drilled the test borings and installed the groundwater observation wells. The contractor used a bombardier drill rig to advance 4-1/4 inside diameter hollow stem augers (HSAs). Soil samples (ASTM D 1586) were obtained generally at 5 ft. intervals, however near continuous sampling was completed within the upper 10 ft. The test borings, which ranged in depth from 12 to 38 ft., all terminated within naturally-deposited glacial outwash.

At B-3, B-12, and B-13, a 2 in. diameter PVC groundwater observation well, with slotted screen for the bottom 10 ft., was installed in the completed test boring. Table II contains well installation information and observations of groundwater made by GNCB; well details are also shown on the respective Monitoring Well Installation Reports prepared by the contractor.

## **V. SUBSURFACE AND GROUNDWATER CONDITIONS:**

### **A. Subsurface Conditions at the Building and Parking Areas**

The test borings revealed that the overburden soils consist of a surface man-placed fill, forest mat/topsoil and subsoil that is underlain by a thick glacial outwash. The soils encountered, progressing downward from ground surface, are described below:

<u>Thickness of Strata (ft.)</u>	<u>General Description</u>
Up to 3.5 ft.	Medium dense to dense, brown or gray, silty medium to fine sand, little gravel to a silty fine SAND, with trace amounts of brick and concrete. (MAN-PLACED FILL)
0.0 to 1.0	Medium dense yellow-brown fine sandy SILT (SUBSOIL)
0.0 to 5.5	Dense to very dense brown gravelly coarse to fine SAND, little to trace silt (GLACIAL OUTWASH DEPOSIT- UPPER)
as much as 32.5	Dense brown stratified silty fine SAND to brown coarse to fine SAND, trace fine gravel (GLACIAL OUTWASH DEPOSIT - LOWER)

Within the building and adjacent parking area, the test borings encountered a man-placed fill that blankets this area and is typically less than 3.0 ft. thick. In general, the man-placed fill is a granular soil except for the surface topsoil, which blankets the site and is typically less than 8 in. thick. At a few locations (B-2, 11, and 15) test borings encountered a thin natural subsoil layer. The major soil unit below the man-placed fill and/or subsoil consists of a glacial outwash deposit, composed of an upper sand and gravel grading finer at depth to a coarse to fine sand and fine sand. The upper coarser sand and gravel is primarily absent from the lower elevated areas of the site; we suspect that these upper glacial outwash soils, and even the subsoil which is primarily absent, was removed during excavation completed many years ago. The test borings all terminated within the finer lower glacial outwash, penetrating this layer by as much as 32.5 ft. (at B-2). Drawing 2 contains contours of top of the natural inorganic glacial outwash deposit, as interpolated from the test borings; Table I also summarizes the elevation top of glacial outwash at each test boring.

As previously noted, the previous test boring GZ-1 cored 5 ft. of Grey White granitic GNESS. The top of cored rock was at El. 323.8. The rock RQD (i.e. percentage of rock pieces greater than 4 in.) was 0 percent.

**B. Subsurface Conditions at the North End of Site**

At the north end of the site, where a force main pipe was initially suggested, subsurface conditions are similar to the above described soils at the building, except the upper sand and gravel is somewhat thicker. Most of the borings terminated within this upper material at a depth of 17 ft. In addition, there are random areas of thin organic silt and alluvium, all typically less than 5 ft. in combined thickness; these organic soils and alluvium are associated with nearby stream activity.

**C. Groundwater Conditions**

Measured water levels at the three groundwater wells indicate that groundwater has a slight downward gradient from west to east, ranging from about El. 365 (at B-3/OW) to El. 363 (at B-13/OW). Water levels observed at the test borings following completion of the borehole are summarized on Table I; these water levels however may not reflect the static groundwater level since they were made over a short period of time and the water level may not have stabilized. Regardless, water levels at the site may vary based on seasonal effects, rain fall, construction activity, local dewatering and other factors. As a result, the water levels at the time of construction or after project completion, may differ from the water levels shown in the observation wells or test borings.

## **VI. RECOMMENDATIONS FOR FOUNDATION DESIGN AND CONSTRUCTION:**

### **A. Building Foundations and Ground Floor Slab**

In our opinion, the man-placed fill, forest mat/topsoil, and subsoil are not suitable to support the building frame or ground floor. We recommend that the building walls and columns be supported on reinforced concrete spread footings bearing on the naturally-deposited glacial outwash, or on compacted structural fill that is placed on the suitable bearing soils, after removing the surface unsuitable materials. In addition, the lowest ground floor building slabs may be earth supported. We recommend that within the building, all man-placed fill, forest mat/topsoil, and subsoil be removed from the building limits and it be replaced, where needed, with compacted structural fill.

We recommend the following foundation design criteria for building design:

1. Design accordance with the current 2016 State of Connecticut Building Code, which references the 2012 IBC Code.
2. For frost protection, locate bottoms of footings at least 3.5 ft. below exterior ground surface exposed to freezing.
3. Proportion footings for a net allowable soil bearing pressure of 5 kps per sq. ft. (ksf), provided footings are at least 3 ft. wide. Reduce the allowable soil bearing pressure, in direct proportion to the reduced width, when less than 3 ft.
4. Where compacted structural fill is used to support building footings and slabs carry the foundation preparation and fill to lateral limits extending a distance beyond the edge of the footing equal to the

depth of fill below footing plus two feet, as shown on Drawing 3, “Limits of Compacted Structural Fill Below Footings.”

5. We expect that total footing settlement will range from  $\frac{1}{2}$  to  $\frac{3}{4}$  in. Footing settlement is expected to occur as the load is applied. We do not expect that differential settlement between footings will exceed  $\frac{1}{2}$  in., for footings typically spaced about 20 to 30 ft. apart.
6. Remove all surface man-placed fill, topsoil/forest mat, and subsoil from the building limits, and to the lateral limits required for placement of compacted structural fill. Prior to placing any structural fill within the building, recompact the exposed subgrade within the open excavation area with at least 6 passes of a vibratory roller that weighs at least 10 tons. Replace any soils that are visually unstable with compacted structural fill. Provide a minimum 9 in. thick layer of compacted structural fill below building slabs.

## **B. Foundation Drainage**

Due to the depth of the groundwater below the lowest slab grades, we do not recommend an under-slab drainage system. However, the basement walls below ground, such as the basement wall along the west side of the two-story building, require a perimeter drainage system.

The perimeter system should consist of a 6 in. diameter perforated pipe surrounded by successive 6 in. thick layers of  $\frac{3}{4}$  in. crushed stone and compacted structural fill. The perforated pipe should be connected to a suitable gravity outlet; in addition, the basement wall should be damp proofed. Refer to Drawing 4, “Foundation Drain”, for a summary of the design, including pipe locations and invert grades.

**C. Lateral Earth Pressures**

The exterior basement walls should be designed for soil, surcharge, and seismic loadings. Hydrostatic pressures are not considered since foundation drainage is recommended. The recommended design values, assuming a fixed top of wall situation (i.e. non-cantilever walls) are as follows:

- retained soil: use an equivalent fluid weight of 55 pcf, plus
- surcharge load: use 0.5 times the vertical load, distributed uniformly over the height of wall.
- seismic load: use 9.9 times the wall height, distributed uniformly over the height of the wall.

The following additional criteria apply:

- coefficient of friction: use 0.50 for concrete on the natural silt or compacted structural fill/crushed stone.
- factors of safety: 2.0 for overturning and 1.5 for sliding.

**D. Seismic Criteria**

Table 20.3-1 (Manual ASCE 10-7) referenced in the 2012 IBC Code provides recommendations for seismic site soil class. Based on our interpretation of the test boring logs, we recommend that the building be designed based on a Site Soil Class D. In addition, we recommend that seismic design include spectral acceleration design values for the Town of Watertown of  $S_s=0.189$  and  $S_1=0.064$  that are contained in Appendix N of the 2016 Connecticut Code.

The natural inorganic soils or compacted (structural or common) fill to be placed are not susceptible to liquefaction.



**E. Compacted Structural and Common Fills:**

Fill for use as compacted structural fill below the building, as free-draining fill against basement walls, as fill within the building, and/or as a minimum thickness layer below earth supported concrete slabs, should consist of sandy gravel or gravelly sand, free of organic material, snow, ice or other unsuitable materials, and should be well graded within the following limits:

<u>Sieve Size</u>	<u>Percent Finer By Weight</u>
4 in.	100
¾ in.	45 - 90
No. 4	20 - 80
No. 40	5 - 50
No. 200	0 - 10

Compacted structural fill should be placed in horizontal layers having a maximum loose lift thickness of 9 in. (open areas) or 6 in. (confined areas). Each layer should be compacted to a dry density at least 95 percent of the maximum dry density as determined in accordance with ASTM Test Designation D1557. We expect that the natural glacial outwash will satisfy the gradation requirements for structural fill. Refer to Appendix C for suggested technical specifications for compacted structural fill.

Compacted common fill, which may be used as fill within parking or landscape areas, should comply with the requirements for compacted structural fill except as noted below:

- The gradation requirements shall be revised to a maximum 6 in. size and the maximum percent finer by weight passing on the No.

200 sieve shall be 0 to 20 percent.

- Lifts shall not exceed 12 in. in loose lift thickness.
- Each lift shall be compacted to a minimum dry density at least 93 percent of the density determined by ASTM D 1557.

Based on our visual classifications, we expect that a majority of the existing man-placed fill and glacial outwash soil will be suitable for use as common fill. Potentially suitable excavated soil for use as common (or structural) fill should be separated and grain size analysis tests be performed to confirm their acceptability.

#### **F. Site Perimeter Slopes and Retaining Walls**

Site design requires finish slopes and retaining walls, or a combination of both, around the perimeter of the site. For design, we suggest that soil (fill or cut) slopes be no steeper than 2.5 hor: 1 ver. The slopes should be protected from erosion with a loam and seed cover.

Due to the confined site limits, site retaining wall(s) in the fill area is needed along the east side of the lower paved parking area. A total wall height up to 13 ft. is needed. We suggest the following wall types be considered:

- Conventional reinforced concrete retaining walls.
- Segmented walls (such as Versa-Lok) with horizontal reinforced geogrids for wall heights greater than 4 ft.
- Vegetated walls.

#### **G. Paved Areas**

Paved areas around the site include roadways and vehicle and/or truck parking. Subgrade conditions, after removing the surface forest

mat/topsoil, will typically consist either of the natural glacial outwash soil or man-placed fill. Both of these soils are suitable to remain in place below paved areas. We suggest that the prepared subgrades be proof rolled by at least 4 passes of a fully loaded dump truck. Any visually soft areas should be removed and replaced with compacted structural fill.

We suggest the following pavement design section for vehicle and heavy truck traffic areas.

	<u>Recommended Thickness (in.)</u>	
	<u>Vehicle Areas</u>	<u>Heavy Traffic</u>
Bituminous Concrete (2 lifts)	3.0	4.5
Processed Stone (CTDOT Form 817/Sec M.05.01)	6.0	8.0
Gravel Base (CTDOT Form 817/Sec M.02.06 Grading A)	10.0	12.0

## VII. CONSTRUCTION CONSIDERATIONS:

### A. General

This report section provides comments related to foundation construction, earthwork, and other geotechnical aspects of the project. It will aid those responsible for preparation of contract plans and specifications and those involved with construction monitoring. The contractor must evaluate potential construction problems on the basis of their own knowledge and experience in the area and on the basis of similar projects in other localities, taking into account their own proposed construction equipment and procedures.

**B. Excavation**

Significant excavation, up to about 13 ft. will be required within the west portion of the two-story building. These excavation depths range up to about 13 ft. Based on the test borings completed to date, it appears that the majority of excavated soils will consist of sand and gravel with some silt; bedrock is not anticipated. We expect that normal construction equipment will be adequate for soil removal. Excavation geometry should conform to OSHA excavation regulations contained in 29 CFR Part 1926 dated October 31, 1989. Temporary slopes of 1.5 hor: 1 ver should be stable.

**C. Dewatering**

Water level readings at observation wells suggest that groundwater appears to be well below the anticipated excavation depths. We expect that removal of any accumulated surface water, such as from rainfall or surface water runoff which accumulates within excavations can be accomplished with open sump pumping methods.

**D. Preparation of Bearing Surfaces**

Following footing excavation, we recommend that the footing soil bearing surfaces be recompacted with hand-guided vibratory equipment prior to forming and concreting.

**E. Construction Monitoring**

The recommendations contained in this report are based on the known and predictable behavior of properly engineered and constructed foundations and other facilities. During construction, it will be necessary that experienced personnel be engaged to observe the excavation of unsuitable materials, placement of compacted structural/common fill, and

preparation of footing and slab bearing surfaces; the monitoring of compacted structural fill below buildings is critical to monitor.

**VIII. LIMITATIONS OF RECOMMENDATIONS:**

This engineering report has been prepared for specific application to the DEEP West District Headquarters project at the Black Rock State Park in Watertown, Connecticut, in accordance with generally accepted geotechnical engineering practice. No other warranty, express or implied, is made. The conclusions and recommendations contained in the report must be reviewed for continued applicability to the final project design.

The analyses and recommendations in this report are based in part upon data obtained from the referenced test borings and observation wells. The nature and extent of variations between the explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations contained herein.

During CD Phase work, GNCB plans to prepare an earthwork specification and a geotechnical drawing sheet that will summarize the foundation and earthwork related activities.

**Tables**

**I – Summary of Test Borings**

**II - Summary of Groundwater Readings**

**TABLE I**

**SUMMARY OF TEST BORINGS**

**DEEP WEST DISTRICT HEADQUARTERS**

**AT BLACK ROCK STATE PARK, WATERTOWN, CONNECTICUT**

TEST BORING NO.	TOTAL DEPTH (FT.)	APPROX. GROUND SURFACE ELEV. (FT.)	ELEV. WATER (FT.)	THICKNESS SOIL (FT.)						ELEV. TOP NATURAL GLACIAL OUTWASH (FT.)
				MAN-PLACED FILL	ORGANIC SILT	SUBSOIL	FINE SAND AND SILT (ALLUVIUM)	GLACIAL OUTWASH		
								UPPER SAND & GRAVEL (SG)	LOWER SAND (S)	
<b>AT BUILDING</b>										
B-1	32.0	396.0	366.0	0.5	-	-	-	5.0	26.5+	395.5 (SG)
B-2	22.0	396.0	Below 374.0	0.8	-	0.7	-	-	20.5+	394.5 (S)
B-3/OW	38.0	396.0	OW	1.5	-	-	-	4.0	32.5+	394.5(SG)
B-4	22.0	394.0	Below 372.0	0.5	-	-	-	3.0	18.5+	393.5(SG)
B-5	22.0	380.0	367.0	2.0	-	-	-	-	20.0+	378.0(S)
B-6	17.0	379.0	365.0	2.0	-	-	-	-	15.0+	377.0 (S)
B-7	17.0	376.0	362.0	3.0	-	-	-	-	14.0+	373.0(S)
<b>AT PAVED AREAS</b>										
B-11	12.0	396.5	Below 384.5	0.5	-	0.5	-	5.5	5.5+	395.5(SG)
B-12/OW	13.0	370.0	OW	2.0	-	-	-	-	11.0+	368.0(S)
B-13/OW	22.0	377.0	OW	1.0	-	-	-	-	21.0+	376.0(S)
B-14	12.0	376.0	Below 364.0	1.0	-	-	-	-	11.0+	375.0(S)
B-15	12.0	397.0	Below 385.0	0.5	-	1.0	-	4.5	6.0+	395.5(SG)
<b>AT FORCE MAIN</b>										
B-8	17.0	362.0	358.5	-	2.5 <sup>(1)</sup>	-	1.0	13.5+	-	358.5(SG)
B-9	17.0	361.0	357.5	-	3.0 <sup>(1)</sup>	-	2.0	12.0+	-	356.0(SG)
B-10	17.0	361.0	356.5	0.8	-	1.7	1.0	13.5+	-	357.5(SG)
B-16	17.0	362.0	354.5	2.0	-	-	-	15.0+	-	360.0(SG)
B-17	17.0	367.0	364.0	3.5	3.5	-	-	-	10.0+	360.0 (S)

(1) Material consists of a loamy silt.

**NOTES:**

1. Refer to Drawing 2 for locations of test borings.
2. Elevations are in feet and refer to NAVD 1988 Datum.
3. Refer to Table II for groundwater observation well readings.

**TABLE II**

**SUMMARY OF GROUNDWATER WELLS**

**NEW WEST DISTRICT HEADQUARTERS**

**AT BLACK ROCK STATE PARK, WATERTOWN, CONNECTICUT**

<b>DATE</b>	<b>TIME</b>	<b>B-3/OW</b>	<b>B-12/OW</b>	<b>B-13/OW</b>
November 1, 2018	-	Installed	Installed	Installed
November 1, 2018	1630		364.5	362.0
November 2, 2018	1200	364.0	363.5	362.4
January 3, 2019	AM	365.0	364.4	363.2
		2.0 in. Dia. PVC well installed to tip at El. 360.0. 10.0 ft. Screen; G.S. at El. 396.0.	2.0 in. Dia. PVC well installed to tip at El. 357.0. 10.0 ft. Screen; G.S. at El. 370.0.	2.0 in. Dia. PVC well installed to tip at El. 357.0. 10.0 ft. Screen; G.S. at El. 377.0.

NOTES:

1. Refer to Drawing 2 for locations of groundwater observation wells.
2. Elevations are in feet and refer to NAVD 1988 Datum.



**Drawings**

**1 - Project Locus**

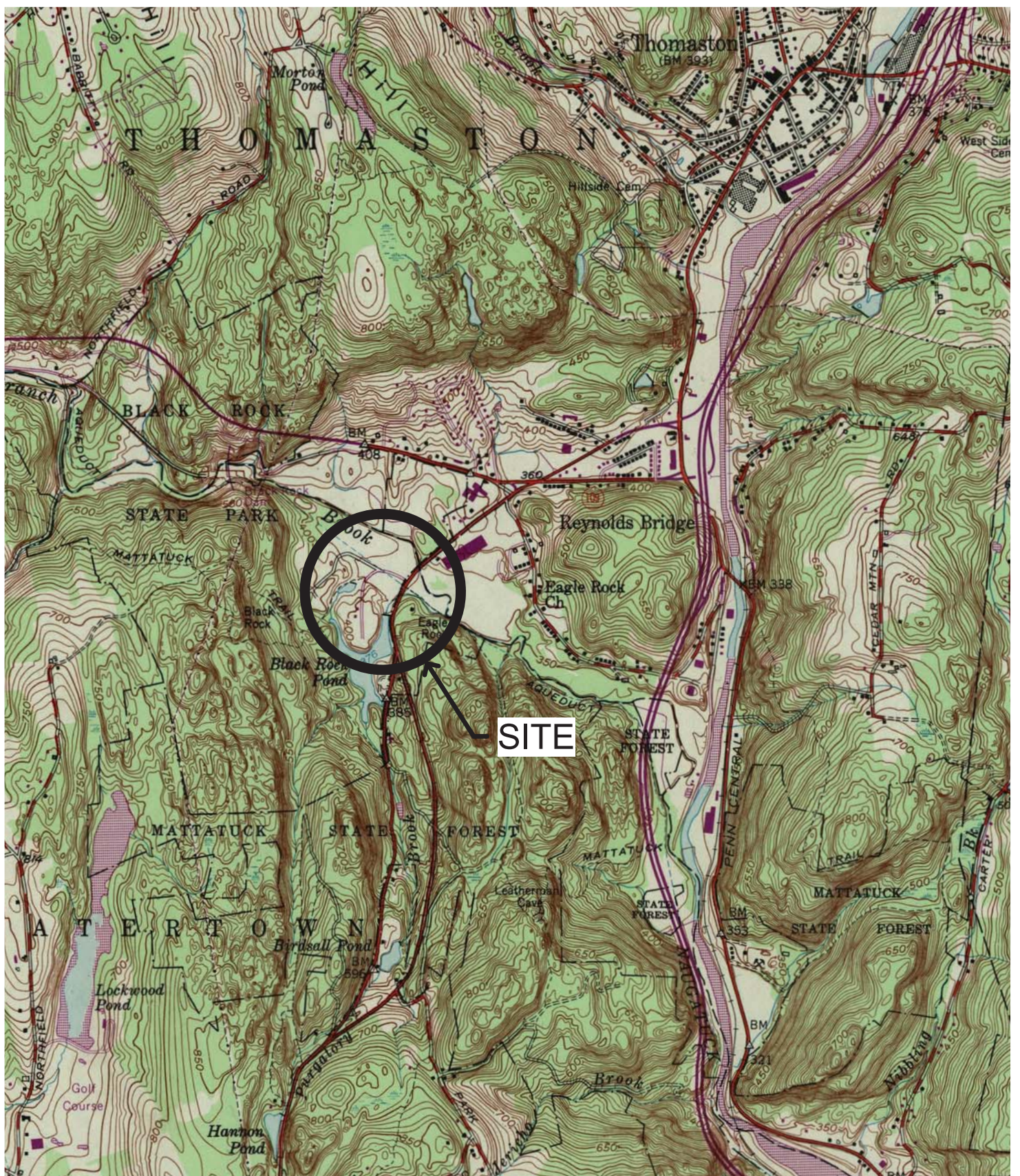
**2 - Test Boring Plan – South**

**2A - Test Boring Plan - North**

**3 – Limits of Compacted Structural Fill Below Footings**

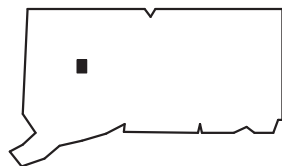
**4- Foundation Drain**





**SITE**

SITE COORDINATES: 41° 39' 06.9" N 73° 05' 49.7" W



U.S.G.S QUADRANGLE: THOMASTON, CT



1358 BOSTON POST ROAD  
 POST OFFICE BOX 802  
 OLD SAYBROOK  
 CONNECTICUT 06475  
 PHONE: 860 388 1224  
 GNCBENGINEERS.COM

DEEP WEST DISTRICT HEADQUARTERS AT BLACK  
 ROCK STATE PARK  
 WATERTOWN, CONNECTICUT  
 PROJECT LOCUS

1" = 2,000 FT.

JANUARY 2019



**LEGEND**



B1



GZ-2

LOCATION OF TEST BORING DRILLED BY SOIL TESTING, INC. OF OXFORD, CONNECTICUT DURING PERIOD NOVEMBER 1 TO 2, 2018; (OW) INDICATES GROUNDWATER OBSERVATION WELL INSTALLED IN COMPLETED TEST BORING.

LOCATION OF TEST BORING DRILLED BY GLENN DRILLING OF COLCHESTER, CONNECTICUT DURING THE PERIOD OCTOBER - NOVEMBER 1982.

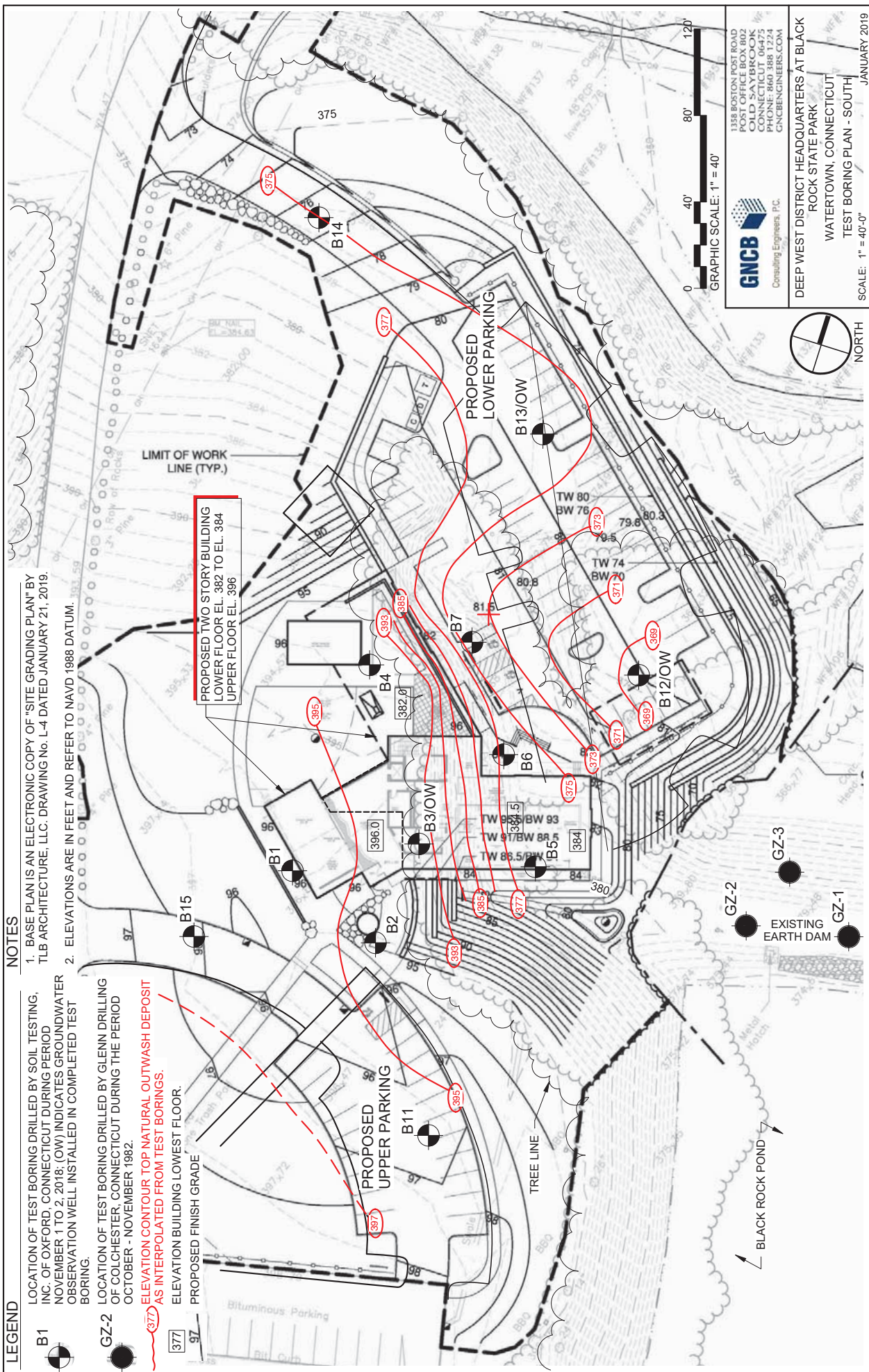
**377** ELEVATION CONTOUR TOP NATURAL OUTWASH DEPOSIT AS INTERPOLATED FROM TEST BORINGS.

**377** ELEVATION BUILDING LOWEST FLOOR.

**97** PROPOSED FINISH GRADE

**NOTES**

1. BASE PLAN IS AN ELECTRONIC COPY OF "SITE GRADING PLAN" BY TLB ARCHITECTURE, LLC, DRAWING No. L-4 DATED JANUARY 21, 2019.
2. ELEVATIONS ARE IN FEET AND REFER TO NAVD 1988 DATUM.

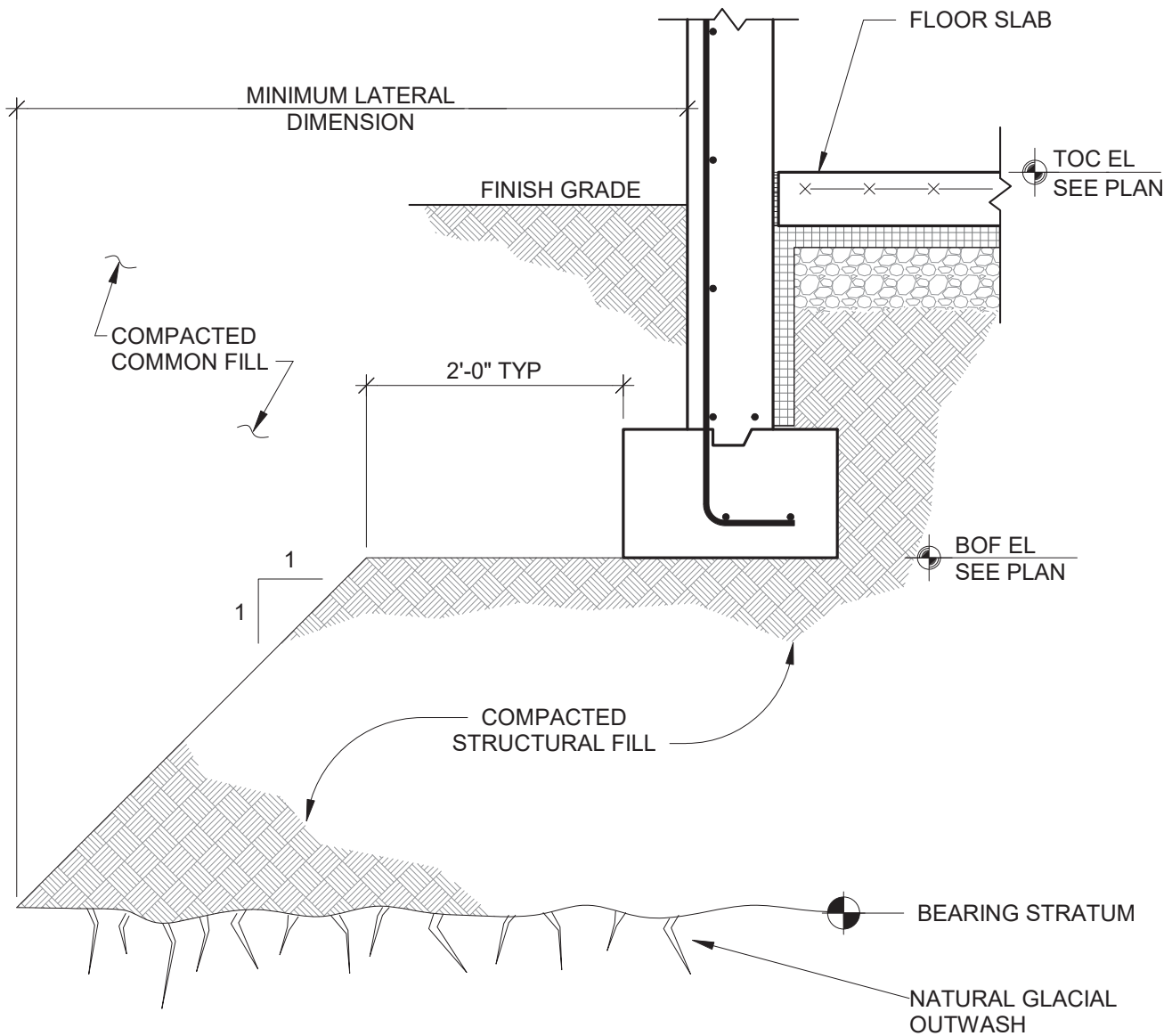


1355 BOSTON POST ROAD  
 OLD SAYBROOK  
 CONNECTICUT 06475  
 PHONE: 860 388 1224  
 GNCBENGINEERS.COM

DEEP WEST DISTRICT HEADQUARTERS AT BLACK  
 ROCK STATE PARK  
 WATERTOWN, CONNECTICUT  
 TEST BORING PLAN - SOUTH  
 SCALE: 1" = 40'-0"  
 JANUARY 2019  
 DRAWING 2







TYPICAL EXTERIOR WALL

LIMITS OF COMPACTED STRUCTURAL FILL BELOW FOOTINGS

① 3/4" = 1'-0"



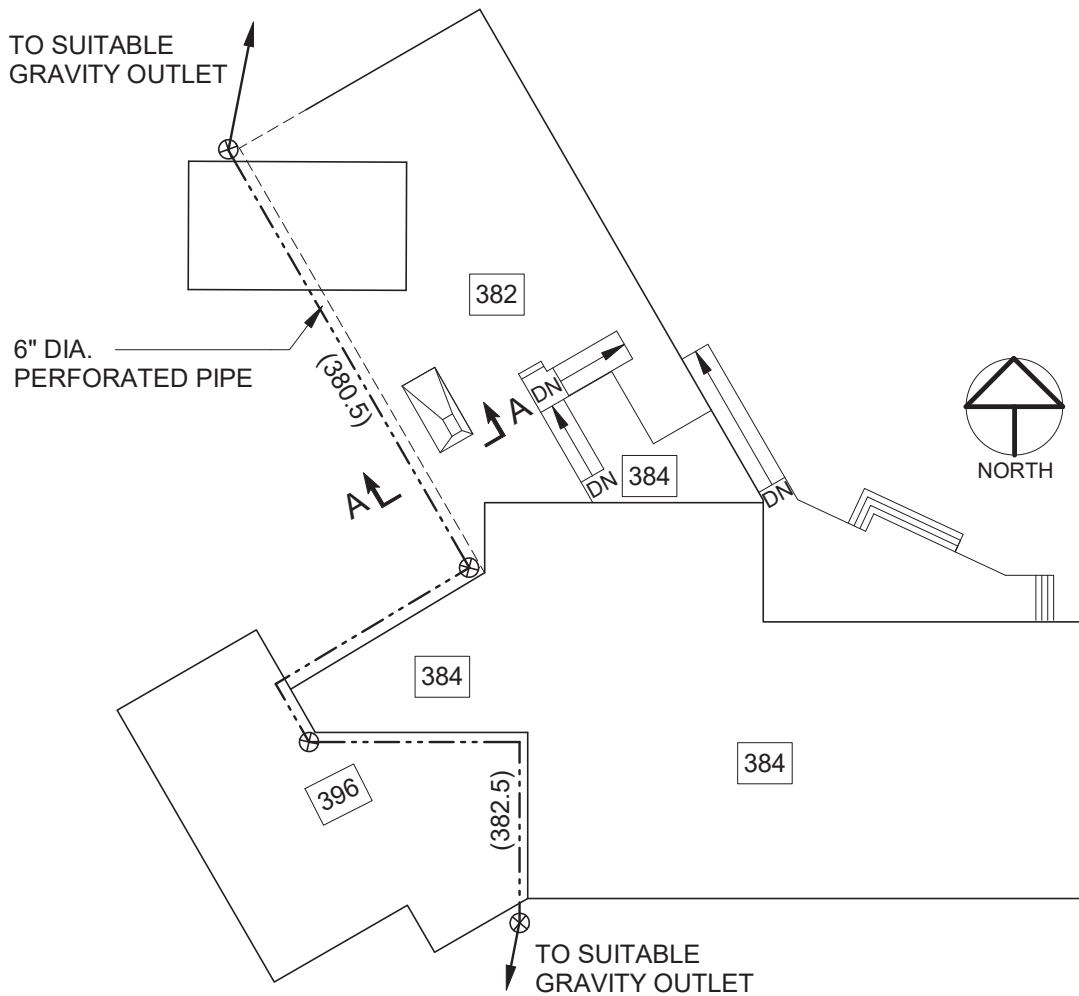
1358 BOSTON POST ROAD  
POST OFFICE BOX 802  
OLD SAYBROOK  
CONNECTICUT 06475  
PHONE: 860 388 1224  
GNCBENGINEERS.COM

DEEP WEST DISTRICT HEADQUARTERS AT BLACK  
ROCK STATE PARK  
WATERTOWN, CONNECTICUT  
LIMITS OF COMPACTED STRUCTURAL FILL BELOW  
FOOTINGS

SCALE: 3/4" = 1'-0"

JANUARY 2019





**LEGEND.**

- 6 IN. DIA. PERFORATED PIPE
- (380.5) EL. PIPE INVERT
- 380.5 EL. BLDG FINISH CONCRETE SLAB
- ⊗ CLEAN OUT

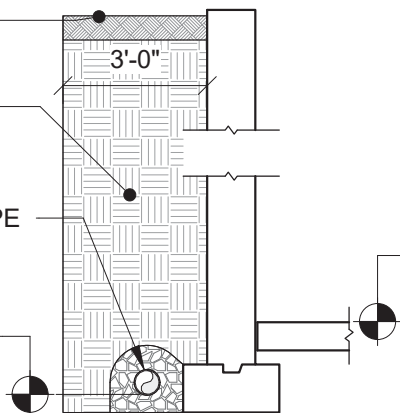
**3 PLAN VIEW**  
1" = 30'-0"

6 IN. IMPERVIOUS FILL  
(OUTSIDE BLDG.)

COMPACTED  
STRUCTURAL FILL

6 IN. DIA. PERFORATED PIPE  
SURROUNDED BY 6 IN. OF  
1/2 IN. STONE

PIPE INVERT  
EL. 380.5 (OUTSIDE BLDG)  
EL. 382.5 (INSIDE BLDG)



TOC 382 (OUTSIDE BLDG)  
TOC 384 (INSIDE BLDG)

**2 SECTION A-A**  
1/4" = 1'-0"



1358 BOSTON POST ROAD  
POST OFFICE BOX 802  
OLD SAYBROOK  
CONNECTICUT 06475  
PHONE: 860 388 1224  
GNCBENGINEERS.COM

DEEP WEST DISTRICT HEADQUARTERS AT BLACK  
ROCK STATE PARK  
WATERTOWN, CONNECTICUT  
FOUNDATION DRAIN

SCALE: As indicated

JANUARY 2019

**Appendix A**  
**Previous Test Boring Logs (1982)**

BORING Co. <u>Glenn Drilling</u> FOREMAN <u>R. Glenn</u> GZA ENGINEER <u>R.M. Downes</u>	BORING LOCATION <u>See Plan Fl 376.8 (NAVD 88)</u> GROUND SURFACE ELEVATION <u>377.8</u> DATUM <u>USGS</u> DATE START <u>11-2-82</u> DATE END <u>11-2-82</u>
--	--

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb. HAMMER FALLING 30 in. CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb. HAMMER FALLING 24 in.	<b>GROUNDWATER READINGS</b>																				
	<table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>DATE</th> <th>TIME</th> <th>WATER AT</th> <th>CASING AT</th> <th>STABILIZATION TIME</th> </tr> </thead> <tbody> <tr> <td>11-2-82</td> <td>1700</td> <td>16.7</td> <td>*</td> <td>1 hr.</td> </tr> <tr> <td colspan="5" style="text-align: center;">Reservoir Fully Drawn Down</td> </tr> <tr> <td colspan="5" style="text-align: center;">*Observation well reading</td> </tr> </tbody> </table>	DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME	11-2-82	1700	16.7	*	1 hr.	Reservoir Fully Drawn Down					*Observation well reading				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME																	
11-2-82	1700	16.7	*	1 hr.																	
Reservoir Fully Drawn Down																					
*Observation well reading																					

DEPTH (ft)	CASING (bl/ft)	SAMPLE				SAMPLE DESCRIPTION CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
		No.	PEN. (in) REC.	DEPTH (ft)	BLOWS/6"			
0		S-1	18/5	0.0-1.5	3/6/12	Brown f/c SAND and f/c Gravel, trace Silt with organics	1	
5		S-2	18/7	5.0-6.5	4/7/6	Brown f/c SAND and f/c Gravel trace Silt with organics		Brown SAND and Gravel: FILL (Dam Embankment)
10		S-3	18/11	10.0-11.5	5/9/16	Brown f/c SAND, some(+)f/c Gravel, little(-)Silt	2	
15		S-4	24/17	15.0-17.0	2/2/2/2	S-4(top half) Red-Brown f/c SAND some(-)f/c Gravel, little Silt S-4(bottom half) Brown f/c SAND and f/c Gravel, little(-)Silt	3	Sorted SANDS, some Gravel, little Silt: ALLUVIUM (Former Stream Bed)
		S-5	24/18	17.0-19.0	3/4/2/1	Grey-Brown f/c(-)SAND, some f/m Gravel, trace Silt, trace organics		
20		S-6	24/24	19.0-21.0	2/2/3/3	Grey-Brown f/c(-)SAND, some(-) f/m Gravel, trace(+)Silt, trace organics		
25		S-7	24/24	25.0-27.0	10/24/23/24	S-7(top 18") Grey-Brown f/c SAND some f/c Gravel, trace Silt S-7(bottom 6") Light Grey f/c(+) SAND - resembles highly decomposed rock		Grey f/c SANDS, some Gravel grading with depth to Grey f/m SANDS  GLACIO-FLUVIAL DEPOSITS
30		S-8	24/12	30.0-32.0	5/8/13/13	Medium to light Grey f(+)/c SAND, little f/c Gravel		

GRANULAR SOILS		COHESIVE SOILS		REMARKS:
BLOWS/FT.	DENSITY	BLOWS/FT.	DENSITY	
0-4	V. LOOSE	< 2	V. SOFT	1. Auger cuttings - Brown Sand and Gravel with large amount of coarse gravel. 2. Auger chatter 12 to 13. 3. Sample S-4 in 2 jars.
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
>50	V. DENSE	15-30	V. STIFF	
		>30	HARD	



GOLDBERG-ZOINO & ASSOCIATES, INC.  
 320 NEEDHAM ST., NEWTON UPPER FALLS, MA.  
 GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT  
 Black Rock Pond Dam  
 Watertown, CT.

REPORT OF BORING No. GZ-1  
 SHEET 2 OF 2  
 FILE No. T-3446  
 CHKD. BY WHH

BORING Co. \_\_\_\_\_ BORING LOCATION EL 376.8 (NAVD 88)  
 FOREMAN \_\_\_\_\_ GROUND SURFACE ELEVATION \_\_\_\_\_ DATUM \_\_\_\_\_  
 GZA ENGINEER \_\_\_\_\_ DATE START \_\_\_\_\_ DATE END \_\_\_\_\_

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb. HAMMER FALLING 30in.  
 CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb. HAMMER FALLING 24 in.

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME

CASING SIZE: \_\_\_\_\_ OTHER: \_\_\_\_\_

DEPTH (ft)	CASING (bi/ft)	SAMPLE			BLOWS/6"	SAMPLE DESCRIPTION CLASSIFICATION	REMARKS	STRATUM DESCRIPTION
		No.	PEN. (in) REC.	DEPTH. (ft)				
35		S-9	24/24	35.0-37.0	4/9/11/12	Grey-Brown f/c SAND, trace(+) Silt	4	
40		S-10	24/15	40.0-42.0	5/5/10/15	Grey-Brown f(+)/m SAND, little(+) Silt		Grey f/m SANDS GLACIO-FLUVIAL DEPOSITS
45		S-11	24/0	45.0-47.0	17/40/39/31	No recovery		
		S-11A	24/10	45.0-47.0		Grey-Brown f(+)/c SAND, little Silt	5	
50		S-12	24/0	50.0-52.0	23/29/20/39	No recovery	6	
		S-12A	0/2	52.3		Recovered wash - Grey f/c(+) SAND	7	
55		Run # 1	60/52	53.0-58.0		Cored Grey White Granitic GNEISS RQD = 0 Drilling Times 53 to 54 6 min. 54 to 55 " 55 to 56 " 56 to 57 " 57 to 58 5½ min.	8	53.0
60							9	
							10	58.0 END OF EXPLORATION - 58.0 Installed 1½" dia. observation well, 49.5 ft. deep, screen at 44.5 to 49.5

GRANULAR SOILS		COHESIVE SOILS		REMARKS:
BLOWS/FT.	DENSITY	BLOWS/FT.	DENSITY	
0-4	V. LOOSE	< 2	V. SOFT	4. Bottom blew into augers while augering, washed with chopping bit to 35, drove sample, bottom blew into augers after pulled sample. 5. Sample S-11 redriven as sample S-11A for sample, spoon possibly grouted in auger while driving S-11 or possibly pushing cobble. 6. Auger chatter and hard augering 47 to 53. 7. Spoon broke off in hole. 8. Tried driving spoon at 52.3 - Spoon bounced. 9. Augers refused at 53. 10. Core barrel - BX single tube, possible 1"(-)seam or joint at 57.
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
>50	V. DENSE	15-30	V. STIFF	
		>30	HARD	



NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.  
 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZ-1

GOLDBERG-ZOINO & ASSOCIATES, INC.  
 320 NEEDHAM ST., NEWTON UPPER FALLS, MA.  
 GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS

PROJECT  
 Black Rock Pond Dam  
 Watertown, CT.

REPORT OF BORING No. GZ-2  
 SHEET 1 OF 1  
 FILE No. T-3446  
 CHKD. BY VWH

BORING Co. New England Boring Contractors BORING LOCATION See Plan EL. 377.6 (NAVD 88)  
 FOREMAN G. Preli GROUND SURFACE ELEVATION 378.6 DATUM USGS  
 GZA ENGINEER R.M. Downes DATE START 10-21-82 DATE END 10-21-82

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140lb. HAMMER FALLING 30 in.  
 CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 300lb. HAMMER FALLING 24 in.  
 CASING SIZE: 3 1/2" HSA OTHER:

GROUNDWATER READINGS				
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME
10-21	1000	17.9	17.0	5 min.
10-21	1430	17.9	*	1 hr.
Reservoir Fully Drawn Down				

DEPTH (ft)	CASING (in/ft)	SAMPLE				SAMPLE DESCRIPTION	REMARKS
		No.	PEN. (in) / REC.	DEPTH (ft)	BLOWS/6"		
		S-1	18/9	0.0-1.5	7/6/4	Medium Brown f/c(-)SAND, some f/m Gravel, little Silt w/organics	1
5		S-2	18/7	5.0-6.5	2/3/3	Medium Brown f/c SAND and f/m Gravel, trace Silt w/roots and organics	2
10		S-3	18/10	10.0-11.5	6/9/10	Medium Brown f/c SAND and f/c Gravel, trace(-)Silt, hint of organics	
15		S-4	18/11	15.0-16.5	7/10/8	Brown to Yellow f/c SAND and f(+)/m Gravel, trace Silt	3
		S-5	18/2	17.0-18.5	8/11/8	Brown f/c GRAVEL and f/c Sand	
		S-6	18/7	18.5-20.0	3/4/3	Grey-Brown f/c SAND and f/c Gravel	
20		S-7	18/4	20.0-21.5	3/2/2	Grey-Brown f/c SAND	4
		S-8	18/10	21.5-23.0	5/11/20	Grey-Brown f/c SAND, some(+)f/c Gravel, trace Silt	
25		S-9	18/18	25.0-26.5	1/2/3	Grey-Brown f/c SAND, trace Silt	5
30		S-10	18/12	29.0-31.0	5/14/6/5	Grey-Brown f/m SAND, trace Silt	6

\*Observation well reading  
 STRATUM DESCRIPTION  
 Brown SAND and Gravel FILL (Dam Embankment)  
 Sorted SANDS and GRAVELS ALLUVIUM (Former Stream Bed)  
 Grey f/c SANDS, some Gravel grading with depth to Gray f/m SANDS  
 GLACIO-FLUVIAL DEPOSITS  
 END OF EXPLORATION - 31.0  
 Installed 1 1/2 in. I.D. observation well 3' screen & 25.5' riser screens at 28 to 25 below ground

GRANULAR SOILS		COHESIVE SOILS		REMARKS:
BLOWS/FT.	DENSITY	BLOWS/FT.	DENSITY	
0-4	V. LOOSE	<2	V. SOFT	
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
>50	V. DENSE	15-30	V. STIFF	
		>30	HARD	

1. Auger cuttings - Brown f/c SAND and f/c Gravel including cobbles up to 5".
2. Augered very fast 8' to 10'.
3. Sand and Gravel "rusty", suggestion of stratification.
4. Overdriven 3 in.
5. Rods and plug only would go down to 23 after taking sample.
6. Augered to 30, pulled plug, SS would go down only to 29; overdriven 6 in.



NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.  
 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZ-2

<b>GOLDBERG-ZOINO &amp; ASSOCIATES, INC.</b> 320 NEEDHAM ST., NEWTON UPPER FALLS, MA. <b>GEOTECHNICAL/GEOHYDROLOGICAL CONSULTANTS</b>	<b>PROJECT</b> Black Rock Pond Dam Watertown, CT.	<b>REPORT OF BORING No. GZ-3</b> SHEET <u>1</u> OF <u>1</u> FILE No. T-3446 CHKD. BY WHH
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BORING Co. <u>New England Boring Contractors</u> FOREMAN <u>G. Preli</u> GZA ENGINEER <u>R.M. Downes</u>	BORING LOCATION <u>See Plan EL. 366.3 (NAVD 88)</u> GROUND SURFACE ELEVATION <u>367.3</u> DATUM <u>USGS</u> DATE START <u>10-20-82</u> DATE END <u>10-20-82</u>
--	---

SAMPLER: UNLESS OTHERWISE NOTED, SAMPLER CONSISTS OF A 2" SPLIT SPOON DRIVEN USING A 140 lb. HAMMER FALLING 30 in. CASING: UNLESS OTHERWISE NOTED, CASING DRIVEN USING 140 lb. HAMMER FALLING 18 in.	<b>GROUNDWATER READINGS</b> <table border="1" style="width:100%; border-collapse: collapse;"> <thead> <tr> <th>DATE</th> <th>TIME</th> <th>WATER AT</th> <th>CASING AT</th> <th>STABILIZATION TIME</th> </tr> </thead> <tbody> <tr> <td>10-20</td> <td>1500</td> <td>5.5</td> <td>7.0</td> <td>10 min.</td> </tr> <tr> <td>10-20</td> <td>1600</td> <td>6.0</td> <td>12.0</td> <td>15 min.</td> </tr> <tr> <td>10-21</td> <td>1330</td> <td>6.8</td> <td>*</td> <td>20 hr.</td> </tr> </tbody> </table>	DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME	10-20	1500	5.5	7.0	10 min.	10-20	1600	6.0	12.0	15 min.	10-21	1330	6.8	*	20 hr.
DATE	TIME	WATER AT	CASING AT	STABILIZATION TIME																	
10-20	1500	5.5	7.0	10 min.																	
10-20	1600	6.0	12.0	15 min.																	
10-21	1330	6.8	*	20 hr.																	

DEPTH (ft)	CASING (DI/FT)	SAMPLE			SAMPLE DESCRIPTION	REMARKS
		No.	PEN. (in) / REC.	DEPTH (ft)		
5		S-1	18/7	0.0-1.5	1/1/1	*Observation well reading <b>STRATUM DESCRIPTION</b>  Brown SAND, some Gravel FILL (Dam Embankment)  Coarse SANDS and GRAVELS ALLUVIUM (Former stream bed)  Grey f/c SANDS and GRAVELS  GLACIO-FLUVIAL DEPOSITS  END OF EXPLORATION 13.5'  Installed 1½ in. I.D. observation well: 3' screen & 10' riser Screen at 11.8 to 8.8 below ground
		S-2	18/7	1.5-3.0	6/4/4	
		S-3	18/4	3.0-4.5	4/9/6	
		S-4	18/4	5.3-6.8	9/6/9	
		S-5	18/0	7.0-8.5	20/15/9	
		S-6	18/9	8.5-10.0	9/5/4/4	
		S-7	18/8	12.0-13.5	10/5/5	
10						5.0±
						8.5±
15						

GRANULAR SOILS		COHESIVE SOILS		REMARKS:
BLOWS/FT.	DENSITY	BLOWS/FT.	DENSITY	
0-4	V. LOOSE	<2	V. SOFT	1. Fragments of quartz gravel. 2. 2½ in. dia. piece of Granite stuck in end of spoon. 3. Coarse Sand and bits of Gravel in wash water. 4. Overdriven 6 in. 5. Overdriven 3 in. 6. Reservoir fully drawn down during drilling.
4-10	LOOSE	2-4	SOFT	
10-30	M. DENSE	4-8	M. STIFF	
30-50	DENSE	8-15	STIFF	
>50	V. DENSE	15-30	V. STIFF	
		>30	HARD	



NOTES: 1) THE STRATIFICATION LINES REPRESENT THE APPROXIMATE BOUNDARY BETWEEN SOIL TYPES, TRANSITIONS MAY BE GRADUAL.  
 2) WATER LEVEL READINGS HAVE BEEN MADE IN THE DRILL HOLES AT TIMES AND UNDER CONDITIONS STATED ON THE BORING LOGS. FLUCTUATIONS IN THE LEVEL OF GROUNDWATER MAY OCCUR DUE TO OTHER FACTORS THAN THOSE PRESENT AT THE TIME MEASUREMENTS WERE MADE.

BORING No. GZ-3

**Appendix B**  
**Design Phase Test Boring Logs**

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-1</b>
	PROJECT NAME <b>New West District HQ Black Rock State Park State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
FOREMAN - DRILLER <b>PD/mk</b>	LOCATION <b>426 Bidwell Rd Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b>	OFFSET
GROUND WATER OBSERVATIONS AT <u>30</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	SAMPLER <b>SS</b>	DATE START <b>11/1/18</b>
	CORE BAR	DATE FINISH <b>11/1/18</b>
	SIZE I.D. <b>4 1/4"</b>	SURFACE ELEV. <b>396.0</b>
	HAMMER WT. <b>140#</b>	GROUND WATER ELEV.
	HAMMER FALL <b>30"</b>	

DEPTH	CASING BLOWS PER FOOT	SAMPLE				BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)			CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT	0 - 6	6 - 12				
		1	ss	24"	14"	2'0"	2	12			0'6"	Topsoil
		2	ss	24"	16"	4'0"	18	27		moist dense		LtBrn FMC SAND, FC gravel LtBrn FMC SAND, lit FC gravel
5		3	ss	24"	17"	6'0"	28	31		moist v dense	5'6"	LtBrn FM SAND
							21	18				
10		4	ss	24"	18"	12'0"	4	5		moist compact		LtBrn FMC SAND, lit F gravel
							6	6				
15		5	ss	24"	18"	17'0"	6	6		moist compact		SAME
							8	10				
20		6	ss	24"	18"	22'0"	9	12		moist compact		LtBrn/Ltgrey FMC SAND, sm FC gravel
							11	12				
25		7	ss	24"	18"	27'0"	6	6		vmoist compact		LtGrey/LtBrn VFFM SAND, lit F gravel
							8	9				
30		8	ss	24"	14"	32'0"	4	5		wet compact		LtBrn VFFMC SAND, lit FC gravel
							6	5			32'0"	
35												E.O.B 32'0"
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. B-1</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE



<b>SOIL TESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-2</b>
	PROJECT NAME <b>New West District HQ Black Rock State Park State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
FOREMAN - DRILLER <b>PD/mk</b>	LOCATION <b>426 Bidwell Rd Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING    SAMPLER    CORE BAR	OFFSET
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	TYPE                      HSA      SS	DATE START                      11/1/18
AT <u>  </u> FT AFTER <u>  </u> HOURS	SIZE I.D.                      4 1/4"    1 3/8"	DATE FINISH                      11/1/18
	HAMMER WT.                      140#      BIT	SURFACE ELEV.                      396.0
	HAMMER FALL                      30"	GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18			CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0 - 6	6 - 12	12 - 18				
		1	ss	24"	14"	2'0"	2	2		moist	0'8"	Topsoil	
		2	ss	24"	16"	4'0"	4	15		loose	1'6"	Yel/Brn F sandy SILT	
5							21	19		moist		Brn FMC SAND, FC gravel	
		3	ss	24"	18"	6'0"	12	8		dense			
							12	15		moist compact		Brn/LtBrn FMC SAND, FC gravel	
10													
		4	ss	24"	16"	12'0"	7	7		moist loose		LtBrn/LtGrey FMC SAND, FC gravel	
							7	7					
15													
		5	ss	24"	18"	17'0"	5	5		moist loose		LtBrn/LtGrey VFFM SAND	
							8	8					
20													
		6	ss	24"	18"	22'0"	6	5		moist loose		LtGrey/LtBrn FMC SAND, sm FC gravel	
							6	8			22'0"		
25												E.O.B 22'0"	
30													
35													
40													

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. B-2</b>
A = AUGER    UP = UNDISTURBED PISTON    T = THINWALL    V = VANE TEST	
WOR = WEIGHT OF RODS    WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER    H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10%    LITTLE = 10 - 20%    SOME = 20 - 35%    AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u> HOLE NO. <b>B-3/OW</b>
	PROJECT NO. <b>G199-1136-18</b> PROJECT NAME <b>New West District HQ          Black Rock State Park          State Project NO. BI-T-615</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>PD/mk</b>	LOCATION <b>426 Bidwell Rd          Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE SIZE I.D. HAMMER WT. HAMMER FALL	CASING    SAMPLER    CORE BAR <b>HSA        SS</b> <b>4 1/4"    1 3/8"</b> <b>140#      BIT</b> <b>30"</b>
GROUND WATER OBSERVATIONS AT <u>30</u> ' FT AFTER <u>0</u> HOURS AT <u>  </u> ' FT AFTER <u>  </u> HOURS		OFFSET DATE START            11/1/18 DATE FINISH            11/1/18 SURFACE ELEV.                    396.0 GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)			CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0-6	6-12	12-18				
5		1	ss	24"	17"	2'0"	3	5			wet compact moist dense moist v dense	1'6"	Topsoil; w/ loamy SAND & gravelly MF sand; (FILL)
		2	ss	24"	18"	4'0"	31	28					LtBrn FMC SAND, FC gravel, lit cobbles
		3	ss	24"	16"	6'0"	49	44				5'6"	
10													LtBrn F SAND, lit silt
		4	ss	24"	18"	12'0"	3	5			moist v loose		LtBrn VFF SAND, lit silt
							7	7					
15													LtBrn F SAND
		5	ss	24"	18"	17'0"	4	4			moist v loose		
							6	7					
20													LtBrn FM SAND, sm FC gravel
		6	ss	24"	14"	22'0"	5	8			moist loose		
							9	9					
25													Brn/LtBrn FM SAND, sm FC gravel
		7	ss	24"	19"	27'0"	6	9			moist loose		
							12	9					
30													LtGry VFF SAND, lit gravel
		8	ss	24"	30"	29'0"	10	12			moist compact		
		9	ss	24"	18"	32'0"	3	4					
35													LtBrn VFF SAND
											wet v loose		
		10	ss	24"	17"	38'0"	8	10					
40													E.O.B 38'0" Observation Well @ 36'0"

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. B-3/OW</b>
A = AUGER    UP = UNDISTURBED PISTON    T = THINWALL    V = VANE TEST WOR = WEIGHT OF RODS    WOH = WEIGHT OF HAMMER & RODS SS = SPLIT TUBE SAMPLER    H.S.A. = HOLLOW STEM AUGER PROPORTIONS USED: TRACE = 0 - 10%    LITTLE = 10 - 20%    SOME = 20 - 35%    AND = 35 - 50%	C = COARSE M = MEDIUM F = FINE

Phone  
(203) 262-9328

Telefax  
(203) 264-3414

WHITE PLAINS, N.Y.  
(914) 946-4850



# SOIL TESTING, INC.

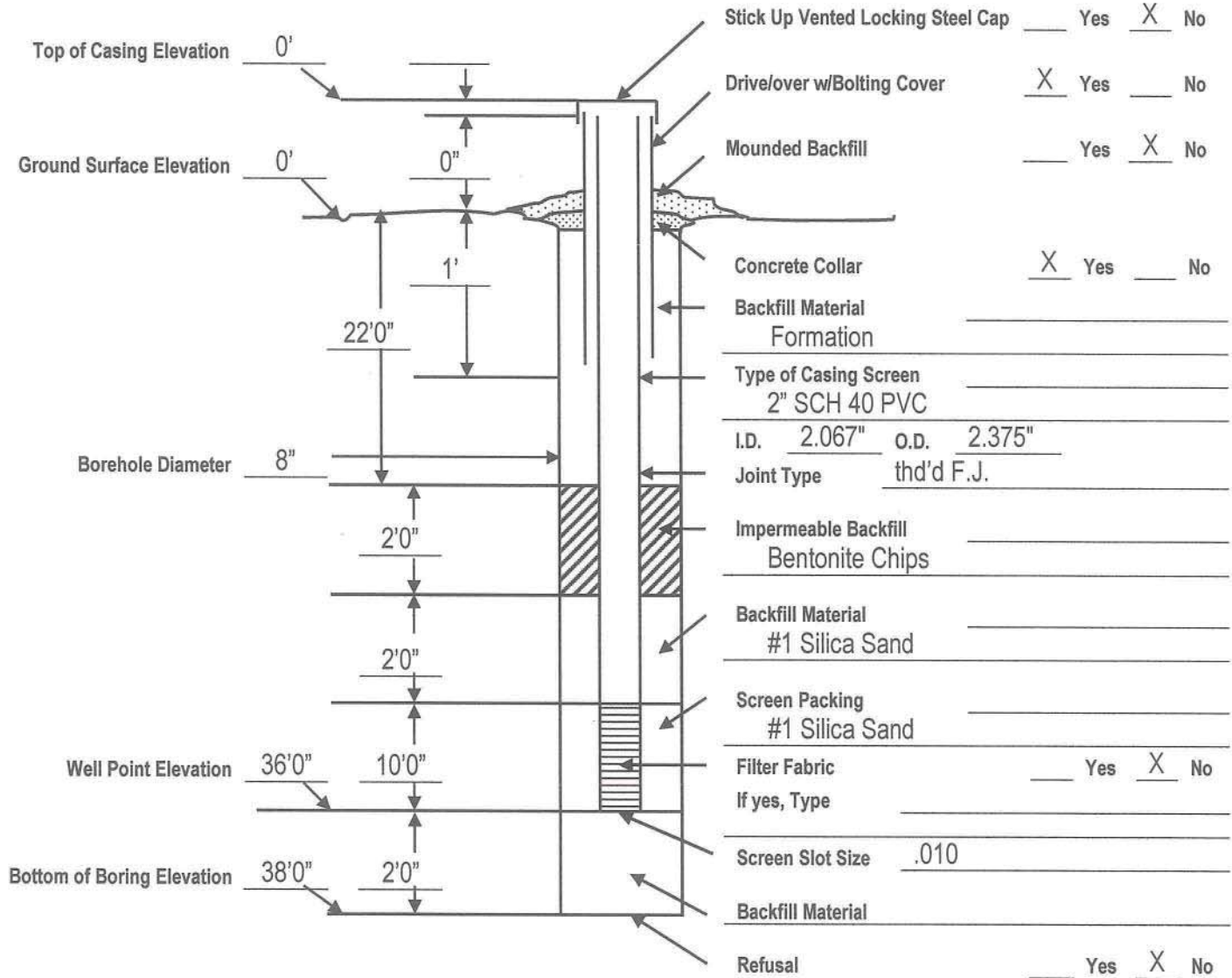
90 DONOVAN ROAD - OXFORD, CONN. 06478-1028

GEOTECHNICAL / ENVIRONMENTAL SUBSURFACE INVESTIGATIONS - Test Borings - Core Drilling  
Monitoring Wells - Recovery Wells - Direct Push/Probe Sampling  
UNDERPINNING - HELICAL PILES - SOIL NAILS

CLIENT: GNCB

JOB #: G193-1136-18

Observation Well # B-3



Stick Up Vented Locking Steel Cap  Yes  No

Drive/over w/Bolting Cover  Yes  No

Mounded Backfill  Yes  No

Concrete Collar  Yes  No

Backfill Material Formation \_\_\_\_\_

Type of Casing Screen \_\_\_\_\_  
2" SCH 40 PVC

I.D. 2.067" o.D. 2.375"

Joint Type th'd'd F.J.

Impermeable Backfill \_\_\_\_\_  
Bentonite Chips

Backfill Material \_\_\_\_\_  
#1 Silica Sand

Screen Packing \_\_\_\_\_  
#1 Silica Sand

Filter Fabric  Yes  No  
If yes, Type \_\_\_\_\_

Screen Slot Size .010

Backfill Material \_\_\_\_\_

Refusal  Yes  No

- Screen 10
- Riser 26
- Plug 1
- Slip Cap \_\_\_\_\_
- Silica Sand 400#
- Powdered Bentonite \_\_\_\_\_

- Bentonite Pellets \_\_\_\_\_
- Bentonite Chips 2/3 bag
- Concrete Mix 1 bag
- Portland Cement \_\_\_\_\_

- Locking Exp. Plug 1
- Lock 1
- D/O 6"
- S/U \_\_\_\_\_



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-4</b>
	PROJECT NAME <b>New West District HQ Black Rock State Park State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
FOREMAN - DRILLER <b>PD/mk</b>	LOCATION <b>426 Bidwell Rd Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b> SAMPLER <b>SS</b> CORE BAR	OFFSET
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>   </u> FT AFTER <u>   </u> HOURS	SIZE I.D. <b>4 1/4"</b> <b>1 3/8"</b> HAMMER WT. <b>140#</b> <b>BIT</b> HAMMER FALL <b>30"</b>	DATE START <b>11/1/18</b> DATE FINISH <b>11/1/18</b> SURFACE ELEV. <b>394.0</b> GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)			CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0 - 6	6 - 12	12 - 18				
5	1	ss	24"	5"	2'0"	7	12		moist compact	0'6"	Topsoil		
						14	14						
						15	7						
5	2	ss	24"	12"	4'0"	16	22		moist compact	3'6"	Brn/LtBrn FMC SAND, FC gravel		
						15	7						
						7	6						
10	3	ss	24"	14"	6'0"	7	7		moist compact		Brn/LtBrn FMC SAND, sm F gravel		
						7	6						
15	4	ss	24"	16"	12'0"	4	6		moist compact		LtBrn FMC SAND, tr F gravel		
						7	7						
20	5	ss	24"	15"	17'0"	6	7		moist compact		LtBrn FMC SAND, lit FC gravel		
						9	9						
25	6	ss	24"	12"	22'0"	10	8		moist compact	22'0"	LtBrn FM SAND, lit C sand, F gravel		
						8	7						
25													
30													
35													
40													

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>B-4</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE	
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-5</b>
FOREMAN - DRILLER <b>PD/ad</b>	PROJECT NAME <b>New West District HQ Black Rock State Park State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
INSPECTOR <b>Garry Jacobsen</b>	LOCATION <b>426 Bidwell Rd Watertown, CT</b>	
GROUND WATER OBSERVATIONS AT <u>13</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	CASING    SAMPLER    CORE BAR TYPE        HSA        SS SIZE I.D.    4 1/4"    1 3/8" HAMMER WT.                140#    BIT HAMMER FALL                30"	OFFSET DATE START                11/1/18 DATE FINISH                11/1/18 SURFACE ELEV.                380.0 GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)			CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0 - 6	6 - 12	12 - 18				
5		1	ss	24"	6"	2'0"	3	5		moist	2'0"	Brn/Dkbrn VFFMC SAND, sm FC gravel, lit silt	
		2	ss	24"	18"	4'0"	6	5		compact			
		3	ss	24"	18"	6'0"	5	5		moist			
10							4	5		loose	SAME	SAME	
							4	3		moist			
							3	4		loose			
15											SAME	Brn/Lt grey FMC SAND, lit F gravel, tr cobbles	
		4	ss	24"	20"	12'0"	4	7		moist			
							8	9		compact			
20											22'0"	Brn/LtBrn VFF SAND	
		5	ss	24"	17"	17'0"	3	5		wet			
							6	5		compact			
25											22'0"	E.O.B 22'0"	
		6	ss	24"	18"	22'0"	3	4		wet			
							4	6		loose			
30													
35													
40													

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO \_\_\_\_\_ FT. USED \_\_\_\_\_ CASING THEN \_\_\_\_\_ CASING TO \_\_\_\_\_ FT. **HOLE NO. B-5**

A = AUGER UP = UNDISTURBED PISTON    T = THINWALL    V = VANE TEST  
 WOR = WEIGHT OF RODS    WOH = WEIGHT OF HAMMER & RODS    C = COARSE  
 SS = SPLIT TUBE SAMPLER    H.S.A. = HOLLOW STEM AUGER    M = MEDIUM  
 PROPORTIONS USED: TRACE = 0 - 10%    LITTLE = 10 - 20%    SOME = 20 - 35%    AND = 35 - 50%    F = FINE



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-6</b>
FOREMAN - DRILLER <b>PD/ad</b>	PROJECT NAME <b>New West District HQ Black Rock State Park State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
INSPECTOR <b>Garry Jacobsen</b>	LOCATION <b>426 Bidwell Rd Watertown, CT</b>	OFFSET
GROUND WATER OBSERVATIONS AT <u>14</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	CASING    SAMPLER    CORE BAR TYPE        HSA        SS SIZE I.D.    4 1/4"    1 3/8" HAMMER WT.        140#     BIT HAMMER FALL        30"	DATE START        11/2/18 DATE FINISH       11/2/18 SURFACE ELEV.        379.0 GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)		CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0 - 6	6 - 12				
5		1	ss	24"	10"	2'0"	3	5		moist	1'0"	DkBrn loamy SILT & FMC SAND
							8	6		compact	2'0"	LtBrn FMC SAND, sm FC gravel (FILL)
		2	ss	24"	14"	4'0"	4	4		moist		
							8	2		compact		
		3	ss	24"	16"	6'0"	3	3		moist		LtBrn VFFM SAND, lit F gravel
10							3	3		loose		
		4	ss	24"	17"	12'0"	5	8		wet		LtBrn VFF SAND
15							8	9		compact		
		5	ss	24"	18"	17'0"	4	6		wet		LtBrn VFF SAND
20							6	7		loose	17'0"	
												E.O.B 17'0"
25												
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. B-6</b>
A = AUGER    UP = UNDISTURBED PISTON    T = THINWALL    V = VANE TEST	
WOR = WEIGHT OF RODS    WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER    H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10%    LITTLE = 10 - 20%    SOME = 20 - 35%    AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB P.C. Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-7</b>
FOREMAN - DRILLER <b>PD/ad</b>	PROJECT NAME <b>New West District HQ Black Rock State Park</b>	BORING LOCATIONS per Plan
INSPECTOR <b>Garry Jacobsen</b>	LOCATION <b>426 Bidwell Rd State Project# BI-T-615 Watertown, CT</b>	
GROUND WATER OBSERVATIONS AT <u>14</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	CASING TYPE: <b>HSA</b> SAMPLER: <b>SS</b> SIZE I.D.: <b>4 1/4"</b> HAMMER WT.: <b>140#</b> HAMMER FALL: <b>30"</b>	CORE BAR: <b>BIT</b> OFFSET: _____ DATE START: <b>11/2/18</b> DATE FINISH: <b>11/2/18</b> SURFACE ELEV.: _____ GROUND WATER ELEV.: <b>376.0</b>

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)		CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0-6	6-12				
5		1	ss	24"	4"	2'0"	4	4		moist loose	3"	TOPSOIL, DkBrn silt, lit F gravel (FILL)
						4	3		1'0"		Brn/DkBrn FMC SAND, FC gravel, sm silt (FILL)	
		2	ss	24"	14"	4'0"	3	2			3'0"	LtBrn VFFM SAND, sm FC gravel (FILL)
		3	ss	24"	18"	6'0"	2	3				LTBRm VFF SAND, tr silt
							3	4				SAME
10									moist compact		LtBrn/LtGrey FMC SAND, FC gravel	
		4	ss	24"	18"	12'0"	12	11				lit COBBLES 11'-14'0"
							12	12				
15									wet loose	17'0"	Brn FM SAND, tr Brn F gravel	
		5	ss	24"	14"	17'0"	5	5				
							4	5				
20											E.O.B 17'0"	
25												
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>B-7</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB P.C. Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-8</b>
FOREMAN - DRILLER <b>PD/ad</b>	PROJECT NAME <b>New West District HQ Black Rock State Park</b>	BORING LOCATIONS per Plan
INSPECTOR <b>Garry Jacobsen</b>	LOCATION <b>426 Bidwell Rd State Project# BI-T-615 Watertown, CT</b>	OFFSET
GROUND WATER OBSERVATIONS AT <u>3.6</u> FT AFTER <u>0</u> HOURS	CASING TYPE <b>HSA</b> SAMPLER <b>SS</b> CORE BAR	DATE START <b>11/2/18</b>
AT <u>   </u> FT AFTER <u>   </u> HOURS	SIZE I.D. <b>4 1/4"</b> <b>1 3/8"</b>	DATE FINISH <b>11/2/18</b>
	HAMMER WT. <b>140#</b> BIT	SURFACE ELEV. <b>362.0</b>
	HAMMER FALL <b>30"</b>	GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE				BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)			CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0 - 6	6 - 12				
5		1	ss	24"	14"	2'0"	3	3		moist loose	2'6"	Blk/DkBrn SILT, Topsoil
		2	ss	24"	16"	3'7"	3	7		wet compact	3'6"	LtBrn FM SAND (Alluvium)
							7	50/1"				BOULDER at 3'6" w/ cobbles to 5'0"
10		3	ss	12"	8"	7'0"	19	71		moist v dense		LtBrn/Brn FMC SAND, FC gravel, sm cobbles, lit boulders
		4	ss	24"	16"	12'0"	19	34		wet compact		LtBrn FMC SAND and FC gravel, lit cobbles
15							18	23				
		5	ss	24"	18"	17'0"	34	41		wet v dense	17'0"	Brn/LtBrn FMC SAND, F gravel, sm cobbles, tr boulders
20												E.O.B 17'0"
25												
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO <u>   </u> FT. USED <u>   </u> CASING THEN <u>   </u> CASING TO <u>   </u> FT.	<b>HOLE NO. B-8</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u> HOLE NO. <b>B-9</b>
	PROJECT NO. <b>G199-1136-18</b> PROJECT NAME <b>New West District HQ          Black Rock State Park          State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
FOREMAN - DRILLER <b>PD/ad</b>	LOCATION <b>426 Bidwell Rd          Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING    SAMPLER    CORE BAR TYPE            HSA        SS SIZE I.D.        4 1/4"    1 3/8" HAMMER WT.        140#        BIT HAMMER FALL        30"	OFFSET DATE START            11/2/18 DATE FINISH            11/2/18 SURFACE ELEV.            361.0 GROUND WATER ELEV.
GROUND WATER OBSERVATIONS AT <u>36</u> " FT AFTER <u>0</u> HOURS AT <u>  </u> " FT AFTER <u>  </u> HOURS		

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)		CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0 - 6	6 - 12				
		1	ss	24"	6"	2'0"	2	4		moist		DkBrn Silt, topsoil
		2	ss	24"	20"	4'0"	1	2		loose	3'0"	
		3	ss	24"	21"	6'0"	2	4		wet		LtBrn VFF SAND, tr gravel (Alluvium)
5							6	6		loose	5'0"	LtBrn VFFM SAND
							3	3		wet		LtBrn FMC SAND, FC gravel, sm cobbles, tr boulders (NOTE: Boulders & cobbles 5' to 10')
							22	33		compact		Brn stratified to F SAND & SILT, sm FC gravel, lit cobbles
10		4	ss	24"	16"	12'0"	17	13		wet		
							24	26		compact		
15		5	ss	24"	14"	17'0"	7	12		wet		Brn VFFM SAND & F GRAVEL
							15	13		wet	17'0"	
										compact		
20												<b>E.O.B 17'0"</b>
25												
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT.    USED _____ CASING    THEN _____ CASING TO _____ FT.	<b>HOLE NO.    B-9</b>
A = AUGER    UP = UNDISTURBED PISTON    T = THINWALL    V = VANE TEST WOR = WEIGHT OF RODS    WOH = WEIGHT OF HAMMER & RODS    C = COARSE SS = SPLIT TUBE SAMPLER    H.S.A. = HOLLOW STEM AUGER    M = MEDIUM PROPORTIONS USED: TRACE = 0 - 10%    LITTLE = 10 - 20%    SOME = 20 - 35%    AND = 35 - 50%    F = FINE	



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u> HOLE NO. <b>B-10</b>
	PROJECT NO. <b>G199-1136-18</b>	BORING LOCATIONS  per Plan
	PROJECT NAME <b>New West District HQ          Black Rock State Park          State Project NO. BI-T-615</b>	
FOREMAN - DRILLER <b>PD/ad</b>	LOCATION <b>426 Bidwell Rd          Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE <b>HSA</b>	CASING <b>HSA</b>
GROUND WATER OBSERVATIONS AT <u>4'6"</u> FT AFTER <u>5</u> HOURS AT <u>   </u> FT AFTER <u>   </u> HOURS	SIZE I.D. <b>4 1/4"</b>	SAMPLER <b>SS</b>
	HAMMER WT. <b>140#</b>	CORE BAR <b>BIT</b>
	HAMMER FALL <b>30"</b>	OFFSET
		DATE START <b>11/2/18</b>
		DATE FINISH <b>11/2/18</b>
		SURFACE ELEV. <b>361.0</b>
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE				BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0-6 6-12 12-18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.					
5		1	ss	24"	17"	2'0"	2 2	moist	8"	Topsoil
						2 3	v loose	2'6"	Brn SILT, FM sand, Lit gravel (subsoil)	
		2	ss	24"	15"	4'0"	3 12	moist	3'6"	Brn FMC SAND, FC gravel, lit cobbles, tr boulders
						12 26	compact			
10		3	ss	10"	10"	4'10"	38 50/4"			NOTE: Cobbles & Boulders from 4'5"-6'0" & 6'-10')
						12 24	wet			
		4	ss	24"	18"	7'9"	32 54	v dense		Brn FMC SAND, FC gravel, lit boulders
15		5	ss	24"	18"	12'0"	11 42	wet		Brn FMC SAND, F gravel, lit cobbles, boulder
						21 57	compact			
		6	ss	24"	20"	17'0"	5 7	wet		Brn FMC SAND, FC gravel, lit cobbles
						9 12	compact	17'0"		
20									<b>E.O.B 17'0"</b>	
25										
30										
35										
40										

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO <u>   </u> FT. USED <u>   </u> CASING THEN <u>   </u> CASING TO <u>   </u> FT.	<b>HOLE NO. B-10</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50% F = FINE	

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u> HOLE NO. <b>B-11</b>
	PROJECT NO. <b>G199-1136-18</b>	
	PROJECT NAME <b>New West District HQ Black Rock State Park State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
FOREMAN - DRILLER <b>PD/mk</b>	LOCATION <b>426 Bidwell Rd Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b> SAMPLER <b>SS</b> CORE BAR	OFFSET
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>   </u> FT AFTER <u>   </u> HOURS	SIZE I.D. <b>4 1/4"</b> <b>1 3/8"</b>	DATE START <b>11/1/18</b> DATE FINISH <b>11/1/18</b>
	HAMMER WT. <b>140#</b> BIT	SURFACE ELEV. <b>396.5</b>
	HAMMER FALL <b>30"</b>	GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)		CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0 - 6	6 - 12				
5	1	ss	24"	16"	2'0"	2	3		moist compact moist v dense moist dense	0'6"	Topsoil	
						16	23			1'0"	Yel/Brn F SANDY SILT (Subsoil)	
	2	ss	24"	18"	4'0"	22	32		v dense moist dense	6'6"	Brn/LtBrn FMC SAND, FC gravel	
						23	26					SAME
10	3	ss	24"	20"	7'0"	36	21		moist loose	12'0"	LtBrn F SAND, lit silt	
						21	18					
	4	ss	24"	18"	12'0"	8	6					
						4	5					
15												
20												
25												
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO \_\_\_\_\_ FT. USED \_\_\_\_\_ CASING THEN \_\_\_\_\_ CASING TO \_\_\_\_\_ FT. HOLE NO. **B-11**

A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST  
 WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE  
 SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM  
 PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50% F = FINE



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-12/OW</b>
	PROJECT NAME <b>New West District HQ Black Rock State Park State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
FOREMAN - DRILLER <b>PD/ad</b>	LOCATION <b>426 Bidwell Rd Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b> SAMPLER <b>SS</b> CORE BAR	OFFSET
GROUND WATER OBSERVATIONS AT <u>5/6</u> " FT AFTER <u>0</u> HOURS AT <u>   </u> " FT AFTER <u>   </u> HOURS	SIZE I.D. <b>4 1/4"</b> <b>1 3/8"</b> HAMMER WT. <b>140#</b> <b>BIT</b> HAMMER FALL <b>30"</b>	DATE START <b>11/1/18</b> DATE FINISH <b>11/1/18</b> SURFACE ELEV. <b>370.0</b> GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)		CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT	0 - 6	6 - 12				
5		1	ss	24"	11"	2'0"	5	9		moist	2'0"	Brn FMC SAND, FC gravel, lit silt (FILL)
		2	ss	24"	14"	4'0"	11	12		compact		
							8	10		moist		
		3	ss	24"	20"	7'0"	4	5		compact		
							5	6		moist		
	4	ss	24"	19"	9'0"	5	4		v loose			
10						6	5		wet	13'0"	SAME	
		5	ss	24"	20"	12'1"	5	4				compact
						5	6		wet	13'0"	SAME	
									loose			
15												(Augered to 13'0" to install well)
20												<b>E.O.B 13'0"</b>
25												<b>Observation Well @ 13'0"</b>
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO <u>   </u> FT. USED <u>   </u> CASING THEN <u>   </u> CASING TO <u>   </u> FT.	<b>HOLE NO. B-12/OW</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

Phone  
(203) 262-9328

Telefax  
(203) 264-3414

WHITE PLAINS, N.Y.  
(914) 946-4850

# SOILTESTING, INC.

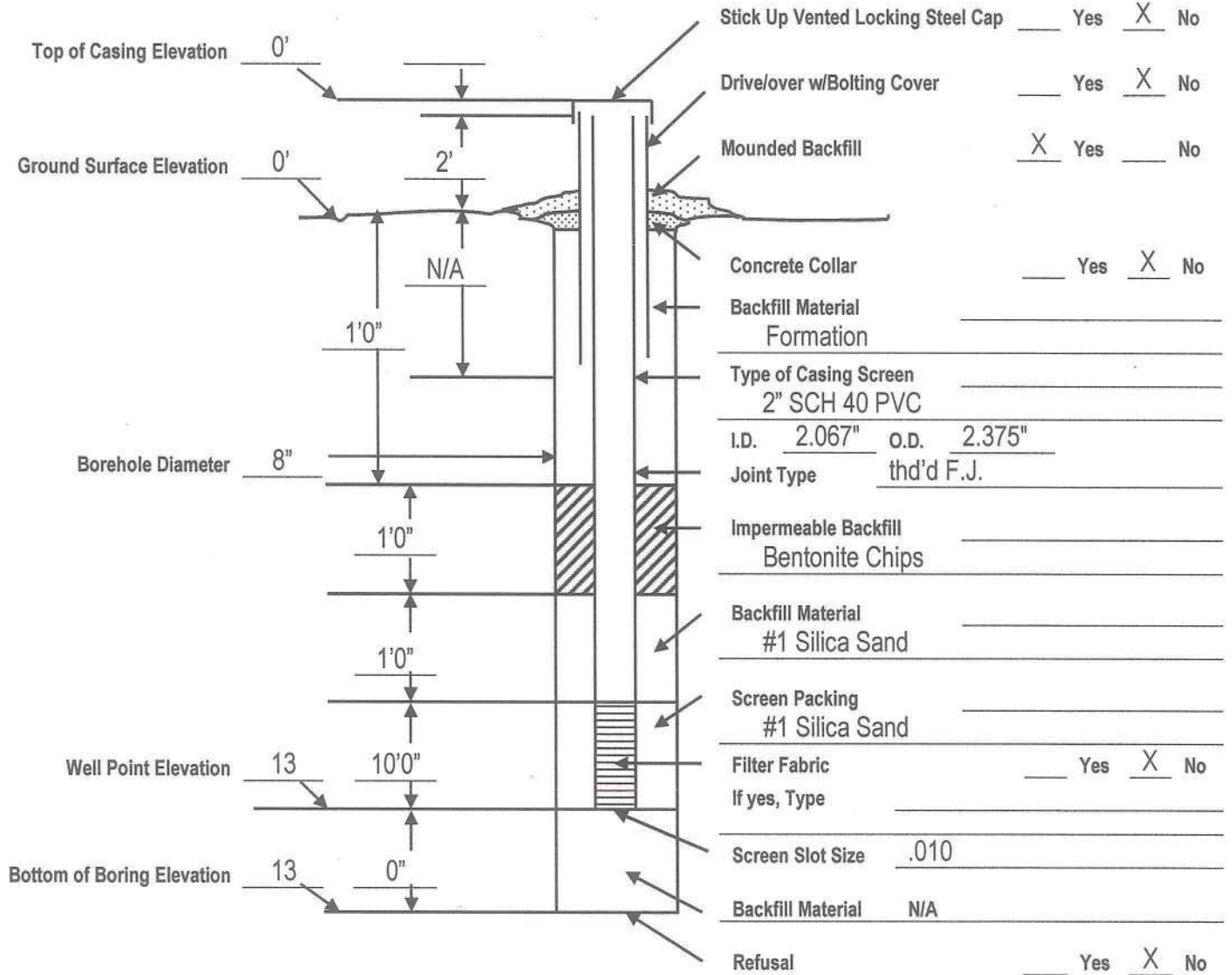
90 DONOVAN ROAD - OXFORD, CONN. 06478-1028

GEOTECHNICAL / ENVIRONMENTAL SUBSURFACE INVESTIGATIONS - Test Borings - Core Drilling  
Monitoring Wells - Recovery Wells - Direct Push/Probe Sampling  
UNDERPINNING - HELICAL PILES - SOIL NAILS

CLIENT: GNCB

Observation Well # B-12

JOB #: G193-1136-18



Screen 10  
Riser 5  
Plug 1  
Slip Cap  
Silica Sand 400#  
Powdered Bentonite

Bentonite Pellets  
Bentonite Chips 2/3 bag  
Concrete Mix  
Portland Cement

Locking Exp. Plug 1  
Lock 1  
D/O  
S/U

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u> HOLE NO. <b>B-13/OW</b>
	PROJECT NO. <b>G199-1136-18</b> PROJECT NAME <b>New West District HQ          Black Rock State Park          State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
FOREMAN - DRILLER <b>PD/ad</b>	LOCATION <b>426 Bidwell Rd          Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE <b>HSA</b> CASING <b>SS</b> SIZE I.D. <b>4 1/4"</b> SAMPLER <b>1 3/8"</b> HAMMER WT. <b>140#</b> CORE BAR <b>BIT</b> HAMMER FALL <b>30"</b>	OFFSET DATE START <b>11/1/18</b> DATE FINISH <b>11/1/18</b> SURFACE ELEV. <b>377.0</b> GROUND WATER ELEV.
GROUND WATER OBSERVATIONS AT <u>14' 6"</u> FT AFTER <u>0</u> HOURS AT <u>   </u> FT AFTER <u>   </u> HOURS		

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)		CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT	0-6	6-12				
5		1	ss	24"	18"	2'0"	4	7		moist	1'0"	5" Topsoil, lit concrete and brick, F gravel (FILL)
							7	8		compact		Brn FM SAND & SILT
		2	ss	24"	16"	4'0"	7	8		moist		LtBrn VFFM SAND, tr F gravel
							7	7		compact		
		3	ss	24"	17"	6'0"	7	7		moist		SAME
10						6	8		compact			
		4	ss	29"	18"	12'0"	4	5		moist v loose		LtGrey/LtBrn VFFM SAND
15							6	8				
		5	ss	24"	17"	17'0"	1	3		wet v loose		LtBrn FM SAND
20							1	2				
		6	ss	29"	18"	22'0"	17	13		wet dense	22'0"	LtBrn/Brn VFFM SAND
25							21	22				E.O.B 22'0"
												Observation Well at 20'0"
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT.	USED _____ CASING	THEN _____ CASING TO _____ FT.	<b>HOLE NO. B-13/OW</b>
A = AUGER    UP = UNDISTURBED PISTON    T = THINWALL    V = VANE TEST	WOR = WEIGHT OF RODS    WOH = WEIGHT OF HAMMER & RODS	C = COARSE	
SS = SPLIT TUBE SAMPLER    H.S.A. = HOLLOW STEM AUGER	PROPORTIONS USED: TRACE = 0 - 10%    LITTLE = 10 - 20%    SOME = 20 - 35%    AND = 35 - 50%	M = MEDIUM	
		F = FINE	





<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB P.C. Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-14</b>
FOREMAN - DRILLER <b>PD/ad</b>	PROJECT NAME <b>New West District HQ Black Rock State Park</b>	BORING LOCATIONS per Plan
INSPECTOR <b>Garry Jacobsen</b>	LOCATION <b>426 Bidwell Rd State Project# BI-T-615 Watertown, CT</b>	OFFSET
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	TYPE HSA SS	DATE START 11/1/18
AT <u>   </u> FT AFTER <u>   </u> HOURS	SIZE I.D. 4 1/4" 1 3/8"	DATE FINISH 11/1/18
	HAMMER WT. 140# BIT	SURFACE ELEV. 376.0
	HAMMER FALL 30"	GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE				DEPTH @ BOT	BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)			CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.		0 - 6	6 - 12	12 - 18				
5	1	ss	24"	14"	2'0"	4	10			moist compact	1'0"	Topsoil & loamy SAND	
	2	ss	24"	17"	4'0"	5	5			moist loose		BRN FM SAND, tr F gravel	
	3	ss	24"	18"	6'0"	5	5			moist loose		Brn/LtBrn FMC SAND, tr F gravel	
						5	4			moist loose		SAME	
10	4	ss	24"	18"	12'0"	4	4			moist compact	12'0"	LtBrn/LtGrey FM SAND, lit F gravel	
						6	5						
15												E.O.B 12'0"	
20													
25													
30													
35													
40													

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>B-14</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE	
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328  NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers, P.C.</b>	SHEET <u>1</u> OF <u>1</u> HOLE NO. <b>B-15</b>
	PROJECT NO. <b>G199-1136-18</b> PROJECT NAME <b>New West District HQ          Black Rock State Park          State Project NO. BI-T-615</b>	BORING LOCATIONS  per Plan
FOREMAN - DRILLER <b>PD/ad</b>	LOCATION <b>426 Bidwell Rd          Watertown, CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE <b>HSA</b> CASING <b>SS</b> SIZE I.D. <b>4 1/4"</b> SAMPLER <b>1 3/8"</b> HAMMER WT. <b>140#</b> CORE BAR <b>BIT</b> HAMMER FALL <b>30"</b>	OFFSET DATE START <b>11/1/18</b> DATE FINISH <b>11/1/18</b> SURFACE ELEV. <b>397.0</b> GROUND WATER ELEV.
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS		

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)		CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT	0 - 6	6 - 12				
5	1	ss	24"	16"	2'0"	1	4		loose moist v dense moist dense	5"	Topsoil	
						4	14			1'6"	Yel/Brn silty F SAND (subsoil)	
	2	ss	24"	12"	4'0"	18	26				Brn/LtBrn FMC SAND, FC gravel, lit cobbles SAME	
	3	ss	24"	14"	6'0"	19	25			6'0"	SAME	
10						21	14		moist loose			
	4	ss	24"	16"	12'0"	7	6			12'0"	Brn/Ltbrn FM SAND	
15											E.O.B 12'0"	
20												
25												
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT.	USED _____ CASING	THEN _____ CASING TO _____ FT.	<b>HOLE NO. B-15</b>
A = AUGER    UP = UNDISTURBED PISTON    T = THINWALL    V = VANE TEST			
WOR = WEIGHT OF RODS    WOH = WEIGHT OF HAMMER & RODS		C = COARSE	
SS = SPLIT TUBE SAMPLER    H.S.A. = HOLLOW STEM AUGER		M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10%    LITTLE = 10 - 20%    SOME = 20 - 35%    AND = 35 - 50%		F = FINE	





<b>SOILTESTING, INC.</b> <b>90 DONOVAN RD.</b> <b>OXFORD, CT 06478</b> <b>CT (203) 262-9328</b> <b>NY (914) 946-4850</b>	CLIENT: <b>GNCB P.C. Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G199-1136-18</b>	HOLE NO. <b>B-17</b>
FOREMAN - DRILLER <b>PD/ad</b>	PROJECT NAME <b>New West District HQ Black Rock State Park</b>	BORING LOCATIONS per Plan
INSPECTOR <b>Garry Jacobsen</b>	LOCATION <b>426 Bidwell Rd State Project# BI-T-615 Watertown, CT</b>	OFFSET
GROUND WATER OBSERVATIONS AT <u>3'0"</u> FT AFTER <u>0</u> HOURS	CASING TYPE <b>HSA</b>	SAMPLER <b>SS</b>
AT <u>    </u> FT AFTER <u>    </u> HOURS	SIZE I.D. <b>4 1/4"</b>	CORE BAR <b>1 3/8"</b>
	HAMMER WT. <b>140#</b>	BIT <b>BIT</b>
	HAMMER FALL <b>30"</b>	DATE START <b>11/2/18</b>
		DATE FINISH <b>11/2/18</b>
		SURFACE ELEV. <b>367.0</b>
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)		CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT	0 - 6	6 - 12				
5		1	ss	24"	17"	2'6"	10	15		moist		6" Asphalt
							12	11		compact	3'6"	LtBrn FMC SAND, sm FC gravel (FILL)
		2	ss	24"	18"	4'6"	10	9		moist		Blk/DkBrn organic SILT
							3	3		compact		
		3	ss	24"	17"	6'0"	1	7		moist		
10							1	3		loose	7'0"	SAME (overdrove spoon to 7')
										wet		
		4	ss	24"	15"	12'0"	11	8		compact		LtBrn VFFM SAND
15							6	6				
		5	ss	24"	17"	17'0"	3	4		wet		LtGrey/LtBrn VFFMC SAND
							5	5		v loose	17'0"	
20												E.O.B 17'0"
25												
30												
35												
40												

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>B-17</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE



**Appendix C**  
**Technical Provisions of Specifications for Compacted Structural**  
**Fill**

TECHNICAL PROVISIONS OF SPECIFICATIONS  
FOR COMPACTED STRUCTURAL FILL

PART 1 – GENERAL:

1.01 DESCRIPTION OF WORK

The work covered by this specification consists of furnishing all plant, labor, equipment and materials and performing all operations in connection with excavation, preparation of subgrade, and providing, placing and compacting Structural Fill within the building.

1.02 QUALITY ASSURANCE

Monitoring of earthwork operations will be provided by the Owner.

The Contractor shall not place a layer of fill until the Owner has observed the underlying materials.

PART 2 – PRODUCTS:

2.01 STRUCTURAL FILL

Structural fill shall be suitable gravel, sandy gravel, or gravelly sand, free of organic material, loam, trash, snow, ice, frozen soil and other objectionable material and shall be well-graded within the following limits:

<u>Sieve Size</u>	<u>Percent Finer by Weight</u>
4 inches	100
¾ inches	45-90
No. 4	20 – 80
No. 40	5 – 50
No. 200	0 – 10

The natural glacial outwash is likely suitable for use as structural fill. The surface topsoil/forest mat, man-placed fill, or any organic soils are not suitable for use as structural fill. As excavation proceeds, the contractor should segregate materials for use, and gradation tests should be completed to conform their suitability. Organic soil and surplus excavated soil shall be legally disposed of.

All material is subject to approval by the Owner's representative.

## PART 3 – EXECUTION:

### 3.01 SUBGRADE PREPARATION

Remove all forest mat/topsoil, man-placed fill, and other unsuitable materials from the building area and to lateral limits extended beyond the footings a distance equal to the depth of fill required below the footing plus two feet. Upon completion of the excavation, the soil subgrade within this open area shall be compacted by at least six coverages by a suitable 10-ton vibratory roller as approved by the Owner. Where, in the opinion of the Owner, compaction of the subgrade is not desirable, the above compaction requirements will be waived.

### 3.02 PLACEMENT OF COMPACTED STRUCTURAL FILL

Structural fill shall be placed in layers not to exceed ten inches in thickness as measured before compaction. Each layer shall be compacted by a minimum of four coverages with the equipment described below to at least 95 percent of maximum dry density as determined by ASTM Test D1557. Incidental compaction due to traffic by construction equipment will not be credited toward the required minimum four coverages.

Compaction equipment in open areas shall consist of vibratory rollers, fully loaded ten-wheel dump trucks, or other compaction equipment approved by the Owner.

Compaction equipment in confined areas (in trenches and adjacent to walls, piers and footings) shall consist of hand-guided vibratory equipment or mechanical tampers as approved by the Owner. Layer thickness prior to compaction shall not exceed six inches.

All fill material shall be placed and compacted "in-the-dry". The Contractor shall dewater excavated areas as required to perform the work and in such a manner as to preserve the undisturbed state of the existing soil subgrade.

The Contractor shall not place a layer of compacted structural fill on snow, ice or soil that was permitted to freeze prior to compaction. Removal of these unsatisfactory materials will be required as directed by the Owner.

In freezing weather, a layer of fill shall not be left in an uncompacted state at the close of a day's operations. Prior to terminating operations for the day, the final layer of fill, after compaction, shall be rolled with a smooth-wheeled roller to eliminate ridges of soil left by tractors, trucks and compaction equipment.

Compacted structural fill shall not be placed when ambient temperatures are below freezing.

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February 17, 2020

TLB Architecture, LLC  
92 West Main Street  
Chester, Connecticut 06412

Attention: Mr. Michael Fortuna, AIA

Sent via e-mail: [mfortuna@tlbarchitecture.com](mailto:mfortuna@tlbarchitecture.com)

Re: Subsurface Data Report  
MCA Utility at DEEP West District Headquarters  
Watertown, Connecticut

Principals  
Charles C. Brown, P.E.  
James F. Norden, P.E.  
Amy Jagaczewski, P.E.

Principal Emeritus  
Kenneth Gible, P.E.

Geotechnical Associate  
David L. Freed, P.E.

Structural Associate  
Richard A. Centola, P.E.

Dear Mr. Fortuna,

This letter report summarizes the results of recent test probes and laboratory rock tests completed for the MCA Utility pipeline at the DEEP West District Headquarters site in Watertown, Connecticut. In 2018, GNCB completed geotechnical engineering investigations for the project building and site design; the results of which have been summarized in a report dated January 21, 2019. The purpose of this additional work was to provide prospective bidding contractors for a 1300 lin. ft. directional drill pipeline with site-specific subsurface data regarding the presence of bedrock and bedrock data with respect to its strength and frequency of fractures. Our work was completed in accordance with our revised February 10, 2020 proposal.

## BACKGROUND

Current design for bringing utilities into the new DEEP West District Headquarters project, from Thomaston, is to drill below ground boreholes using directional drill methods. Initial design, as shown on 50 percent CD Drawings CU101 and CU102 dated December 5, 2019 as prepared by Martinez Couch & Associates, requires a 1300 lin. ft. single (30 in. diameter) and/or (smaller) double bore alignment. Borehole invert grades will typically range from 22 ft. to 24 ft. below ground surface, but as much as 34 ft. at the northern higher ground levels. The alignment must pass below a stream, an active large diameter water line that services adjacent communities, and Branch Brook.

Ground surface along the pipeline is generally flat, but is divided to two levels marked by Branch Brook. The area south of the brook is generally between El. 360 and 363, while north of the brook, ground rises to between El. 380 to El. 386. Note that elevations are in feet and refer to NAVD 1988 Datum.

## SUBSURFACE AND LABORATORY INVESTIGATIONS

Test Probes: To determine the depth to rock and enable recovery of bedrock cores, Martinez Couch & Associates, Inc. prepared a program and field located a subsurface exploration program consisting of 17 test probes (PB#1 to PB#17). GNCB arranged for and monitored the program, as well as interpolated existing topographic plans to determine the approximate ground surface elevation at each exploration. The test probe work was completed during the period January 27 to January 30, 2020. The attached Drawing 1, "Test Probe Plan" shows the locations of the test probes; note that several attempts were needed at a number of locations to advance the probe to bypass near surface cobbles, boulders, or other obstructions.

Soiltesting, Inc. of Oxford, Connecticut, under contract to GNCB, used standard drill rig equipment to advance 4-1/4 in. inside diameter hollow stem augers to the required (35 ft. or 60 ft.) minimum probe depth and/or to top of rock. Except for PB#4, 7, 8, and 11, all the test probes were drilled to refusal. At five of the probes (PB#10, 12, 13, 14A, and 16), a 5 lin. ft. NX (2-1/8 in. diameter) bedrock core was obtained to confirm that the refusal represented the top of sound bedrock. The test probes were drilled to total depths ranging from 6.0 ft. to 55.5 ft. Test probe logs, prepared by the contractor and reviewed by GNCB, are attached as Appendix A; GNCB photographs of the recovered rock core is also included. GNCB prepared the attached Table I, "Summary of Test Probes" and Table II "Summary of Rock Core Data" that summarizes the test probe information, and the results of laboratory tests as discussed below.

Prior to the start of the test probes, locating the active large diameter water service pipe was needed, to ensure it was not damaged. On January 22, 2020, Mr. Michael Francis of AcuMark Utility Locating, under contract to GNCB, visited the site to complete a field locating procedure using GPS and various other utility locating equipment. The work effort successfully located the pipe; its location is as previously shown on site drawings, and on the attached Drawing 1. The field work indicated that the top of pipe is about 4 to 5 ft. below ground surface, in the vicinity of the test probes.

Laboratory Rock Testing: Following the test boring work, GNCB reviewed the test probe core samples and identified four samples (at PB#10, 12, 14A and 16) for testing. The tested core samples consisted of GNEISS, except at PB#10, the test sample consisted of SCHIST. GeoTesting Express of Acton, Massachusetts, under contract to GNCB, completed the following tests,

which were completed in general conformance with ASTM standards; Test results are attached as Appendix B, and are summarized on Table II. The following is a summary of the tests completed.

Unconfined Compression Tests (ASTM D422): Four unconfined compress tests were completed; the compressive strengths ranged from about 14 kips per square inch (ksi) to 24 ksi. The tests were completed with the ASTM minimum required length to diameter ratio of 2, except for the test completed on PB#16/C1 which was 1.45; this unconfined test resulted in the lowest rock strength value of 14 ksi. The test results in Appendix B include a photograph of the test sample before and after failure.

Mohs Hardness Tests: Four Mohs Hardness tests were completed, with results of 3.5 or 7.5. The Mohs scale of mineral hardness (not rock hardness), which ranges from 1 (talc) to 10 (diamond), is a qualitative ordinal scale characterizing scratch resistance of various minerals through the ability of harder material to scratch softer material. While greatly facilitating the identification of minerals in the field, the Mohs scale has been used by directional drilling contractors to help select the specific cutting tools they will use to bore a hole in rock.

## SUBSURFACE SOIL AND ROCK CONDITIONS

While soil samples were not obtained, the soil return from the augers confirmed the conditions encountered during the previous GNCB subsurface exploration program in 2018. Specifically, overburden soil consists of a surface man-placed fill underlain by a granular outwash that consists of an upper brown gravelly coarse to fine SAND with cobble and boulder zones within about 10 ft. of ground surface, grading to a finer coarse to fine SAND. Of note is the approximately 10 ft. thickness of surface fill material encountered in the vicinity of PB#9 where 4 attempts were needed to penetrate to the underlying bedrock. The outwash soils are underlain by bedrock, of which a few of the test probes encountered up to 6 ft. of weathered rock. Except for four test probes previously noted, all the probes encountered a refusal.

The depth to bedrock varies along the intended alignment of the pipeline, ranging from about 20 ft. at the south end dropping to 55 ft. in the center, and then rising at the north end just beyond Branch Brook, where bedrock is within about 10 ft. of ground surface. GNCB identified several outcroppings of bedrock north of the pipeline; refer to the red cross hatching shown on the attached Drawing 1 for approximate locations.

As mentioned previously, bedrock cores were obtained at five test probe locations; all the cores were obtained from the north side of the site, where rock is shallowest. In general, bedrock is fresh to slightly weathered light gray medium grained GNEISS with layers and zones of fine-grained SCHIST. Refer to the detailed descriptions of the bedrock core on Table II, also included on the table are RQD calculations, drilling rates, and no. of fractures per foot. The bedrock core and outcropping observations are consistent.

Water levels observed at the completion of the test borings were typically within 10 ft. of ground surface. These observations, however, were made over a short period of time and may not represent the actual static groundwater level. In any event, water levels vary with precipitation, season, and other factors. As a result, water levels encountered during and after construction may differ from those observed in the explorations.

Please call if you have any questions or require additional information.

Very truly yours,



David L. Freed, P.E.  
Geotechnical Associate

Enclosures: Table I – Summary of Test Probes  
Table II – Summary of Rock Core Data  
Appendix A – Logs of Test Probes and Photographs of Rock Core  
Appendix B – Results of Laboratory Rock Tests

cc: Martinez Couch & Associates, LLC. (Attn. Ms. Rima Laukaitis and Mr. Richard Couch)



## **Tables**

**TABLE I**

**SUMMARY OF TEST PROBES**

**MCA UTILITY AT DEEP WEST BRANCH HEADQUARTERS**

**WATERTOWN, CONNECTICUT**

TEST PROBE NO.	TOTAL DEPTH (FT.)	APPROX. ELEV. GROUND SURFACE (FT.)	THICKNESS STRATA (FT.)			ELEV. TOP BEDROCK (FT.)
			OVERBURDEN SOIL	WEATHERED ROCK	SOUND ROCK	
PB-1(R)	19.0	376	19.0	-	-	357 <sup>(1)</sup>
PB-2 (R)	32.5	362	27.0	5.5	-	329.5 <sup>(1)</sup>
PB-3 (R)	24.0	362	21.0	3.0	-	338 <sup>(1)</sup>
PB-4	35.0	363	35.0+	-	-	Below 328
PB-5 (R)	52.0	362	51.0	1.0	-	310 <sup>(1)</sup>
PB-6 (R)	50.5	363	49.0	1.5	-	312.5 <sup>(1)</sup>
PB-7	35.0	362	35.0+	-	-	Below 327
PB-8	35.0	363	35.0+	-	-	Below 328
PB-9(R)	55.5	361.5	49.0	6.5	-	306 <sup>(1)</sup>
PB-10(C)	30.5	361	24.5	1.0	5.0+	335.5
PB-11	35.0	362	35.0+	-	-	Below 327
PB-12 (C)	13.0	361	8.0	-	5.0+	353
PB-13 (C)	15.0	385	10.0	-	5.0+	375
PB-14(C)	9.5	377	4.5	-	5.0+	372.5
PB-15 (R)	23.0	384	23.0	-	-	361 <sup>(1)</sup>
PB-16 (C)	6.0	386.5	1.0	-	5.0+	385.5
PB-17(R)	28.0	362	26.0	2.0	-	334 <sup>(1)</sup>

(R) Test Probe Refusal

(C) Bedrock core obtained

<sup>(1)</sup> Elevation top rock based on test probe refusal

Notes:

1. Refer to Drawing 1 for locations of test borings.
2. Elevations are in feet and refer to NGVD 88 Datum.

**TABLE II**  
**SUMMARY OF ROCK CORE DATA**  
**MCA UTILITY AT DEEP WEST BRANCH HEADQUARTERS**  
**WATERTOWN, CONNECTICUT**

TEST PROBE NO.	RUN NO.	DEPTH/ELEVATION (FT.)	RECOVERY/RQD		DRILLING RATE (MIN/FT)	NO. OF FRACTURES PER FT.	DESCRIPTION	LAB TEST RESULTS <sup>(1)</sup>	
			IN.	%				COMPR. STRENGTH TEST	MOHS HARDNESS
PB-10	C1	25.5-30.5 336.5-341.5	60/43	100/72	5,5,4,4,4	1(25.5-26.5) 4(26.5-27.5) 1(27.5-28.5) 3(28.5-29.5) 2(29.5-30.5)	Fresh moderately to slightly fractured white, aphanitic Quartz to 26.2 then interbedded light gray medium grained GNEISS and gray SCHIST. Foliation is very thin, moderately dipping to S-SW. Primary joint is moderately dipping, open, rough, planar, slightly weathered. Joint set is parallel to foliation, (to S-SW) Spacing is 2 to 11". No high angle joints.	16.7	7.5
PB-12	C1	8.0 - 13.0 359 - 399	36/12	60/20	3,4,3,4,3	2(8.0-9.0) 4(9.0-10.0) *(10.0-11.0) *(11.0-17.0) *(12.0-13.0)	Fresh to completely weathered, moderately to extremely fractured (below 10') medium grained, light gray GNEISS with layers of fine-grained SCHIST. Foliation is very thin moderately dipping (to S-SW) Primary joint set is moderately dipping, open, rough, planar, slightly to extremely weathered. Joint set is parallel to foliation, (i.e. dipping S-SW) spacing is 6" to < 1/2".	24.1	3.5
PB-13	C1	10.0 - 15.0 375.0-370.0	54/36	90/60	5,4,4,4,4	2(10.0-11.0) 0(11.0-12.0) 0(12.0-13.0) 4(13.0-14.0) 3(14.0-15.0)	Fresh to slightly weathered, extremely to very slightly fractured, light gray, medium grained GNEISS, changing to gray fine-grained SCHIST at 13.2'. Foliation is very thin moderately dipping (to S-SW). Primary joint set is moderately dipping, open rough, planar moderately weathered, joint set is parallel to foliation (to S-SW) with spacing 1/2" to 30". One high angle joint steeply dipping perpendicular to primary (i.e. to N-NE).	-	-
PB-14A	C1	4.5 -9.5 380.5-375.5	49/28	87/47	3,4,3,4,3	1(4.5-5.5) 6(5.5-6.5) 2(6.5-7.5) 2(7.5-8.5) 2(8.5-9.5)	Fresh to slightly weathered (possible extremely weathered core lost) extremely to slightly fractured, light gray medium grained GNEISS. Foliation is very thin moderately dipping to S-SW joint set is moderately dipping, open, rough, planar, slightly weathered. Joint set is parallel to foliation (to S-SW) with spacing of 1" to 18". One high angle joint steeply dipping, perpendicular to primary (i.e. dipping N-NE) contribute to extremely weathered zone approx. 8.5 to 9'.	15.6	7.5

**TABLE II**  
**(Continued)**

**SUMMARY OF ROCK CORE DATA**

PB-16	C1	1.0-6.0 385.5-380.5	50/15	83/23	6,6,5,4,4	5 (1.0-2.0) 2 (2.0-3.0) 3 (3.0-4.0) *(4/0-5.0) 3 (5.0-6.0)	Fresh to extremely weathered, moderately to extremely fractured light gray to brown, medium grained GNEISS. Foliation is very thin, moderately dipping (to the S-SW) Primary joint set is moderate dipping, open, rough, planar, slightly to moderately weathered joint set is parallel to foliation (i.e. dipping S-SW), with spacing of 2 to 6 inches. Secondary joint is steeply dipping perpendicular to primary, (i.e. to the N-NE) open, rough, planar, extremely weathered. Contributes to extremely weathered. Extremely fractured zone from 4.2 to 5.2' approximately. Rock type changes to gray fine-grained SCHIST at 5.5'.	14.0	7.5
-------	----	------------------------	-------	-------	-----------	--	--	------	-----

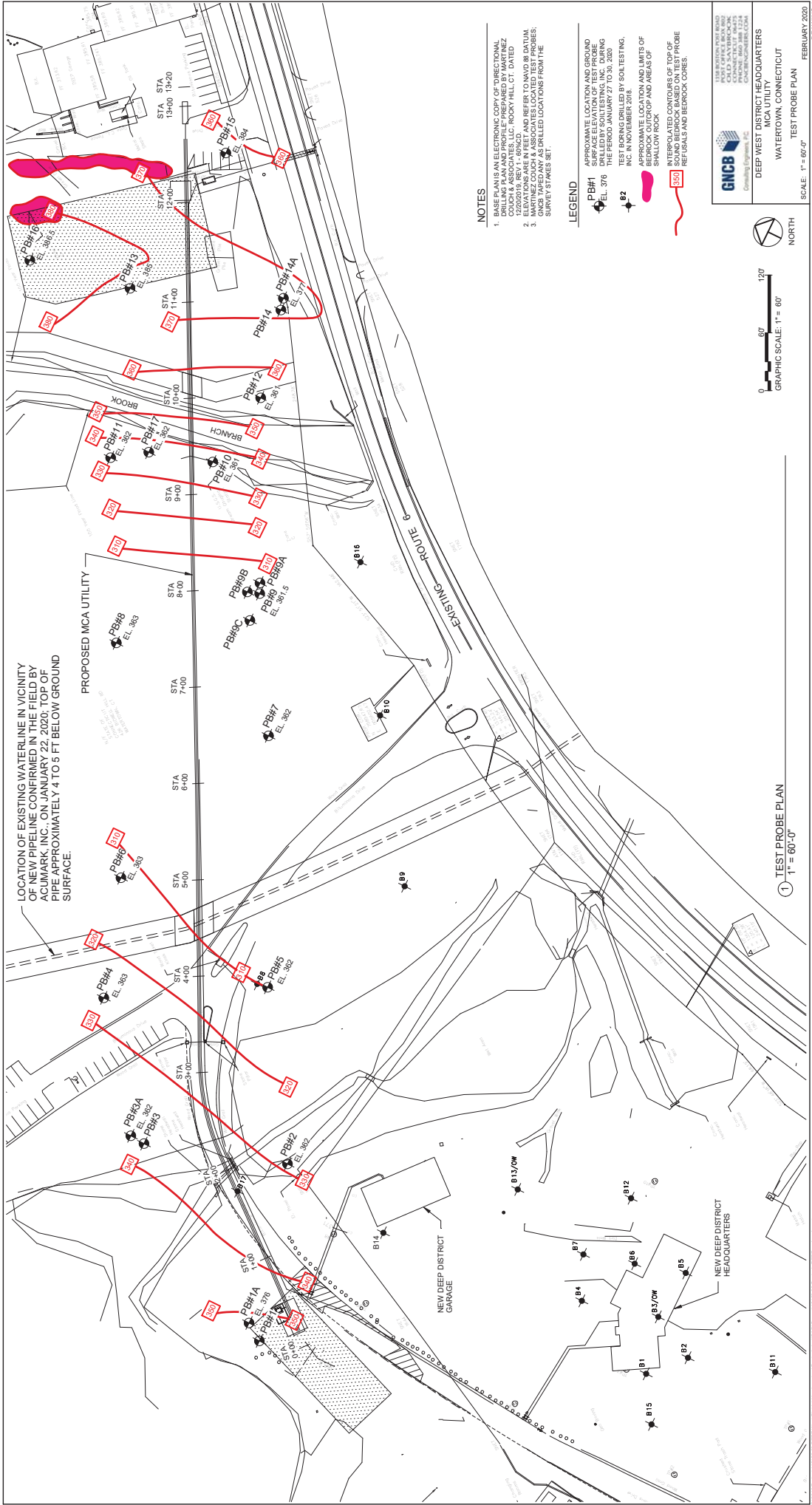
\*Extremely fractured zone

**Notes**

1. Refer to Drawing 1 for locations of test borings.
2. Elevations are in feet and refer to NGVD 88 Datum.
3. The laboratory tests completed on the following rock types.

<b>ROCK TYPE</b>	<b>TEST DEPTHS (FT.)</b>
(SCHIST)	PB10/C1 28.3-28.9
(GNEISS)	PB12/C1 8.6-9.2
(GNEISS)	PB14A/C1 4.7-5.5
(GNEISS)	PB16 1.8-2.4

## Drawings



LOCATION OF EXISTING WATERLINE IN VICINITY OF NEW PIPELINE CONFIRMED IN THE FIELD BY ACUMARK, INC. ON JANUARY 22, 2020; TOP OF PIPE APPROXIMATELY 4 TO 5 FT BELOW GROUND SURFACE.

PROPOSED MCA UTILITY

**NOTES**

1. BASE PLAN IS AN ELECTRONIC COPY OF "DIRECTIONAL DRILLING" BY G. COUCH & ASSOCIATES, LLC, ROCKY HILL, CT, DATED 12/20/2019, REV 11-6/2019.
2. APPROXIMATE LOCATION AND LIMITS OF BEDROCK, OUTCROP AND AREAS OF SHALLOW ROCK CORES AS SET OF SOUND BEDROCK BASED ON TEST PROBE REFUSALS AND BEDROCK CORES.
3. APPROXIMATE LOCATION AND LIMITS OF BEDROCK, OUTCROP AND AREAS OF SHALLOW ROCK CORES AS SET OF SOUND BEDROCK BASED ON TEST PROBE REFUSALS AND BEDROCK CORES.

**LEGEND**

- APPROXIMATE LOCATION AND LIMITS OF BEDROCK, OUTCROP AND AREAS OF SHALLOW ROCK CORES AS SET OF SOUND BEDROCK BASED ON TEST PROBE REFUSALS AND BEDROCK CORES.
- PB#1 EL. 378
- B2
- APPROXIMATE LOCATION AND LIMITS OF BEDROCK, OUTCROP AND AREAS OF SHALLOW ROCK CORES AS SET OF SOUND BEDROCK BASED ON TEST PROBE REFUSALS AND BEDROCK CORES.

**GNCB**  
 CONSULTING ENGINEERS, INC.  
 DEEP WEST DISTRICT HEADQUARTERS  
 MCA UTILITY  
 WATERTOWN, CONNECTICUT  
 TEST PROBE PLAN  
 SCALE: 1" = 60'-0"



① TEST PROBE PLAN  
 1" = 60'-0"

## **Appendix A: Logs of Test Probes and Photographs of Rock Core**



<b>SOIL TESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <u>GNCB Consulting Engineers</u>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <u>G24-1458-20</u>	HOLE NO. <u>PB-1 / PB-1A</u>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>MK/ao</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b>	SAMPLER <b>SS</b>
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	SIZE I.D. <b>3 3/4"</b>	CORE BAR <b>1 3/8"</b>
AT <u>  </u> FT AFTER <u>  </u> HOURS	HAMMER WT. <b>140#</b>	BIT <b>30"</b>
	HAMMER FALL <b>30"</b>	GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					DEPTH @ BOT	BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 - 6 - 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	MOIST						
	<b>PB-1</b>											
5										4'0"	Fill, brick, concrete Auger refusal	
10												<b>E.O.B 4'0"</b>
15												
	<b>PB-1A</b>											
5										5'0"	6" Topsoil Fill, brick concrete	
10											SAME	
15											Brn FMC SAND & FC GRAVEL	
											cobbles 5'-11'	
15											possible BEDROCK	
20										19'0"	Auger refusal	

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO \_\_\_\_\_ FT. USED \_\_\_\_\_ CASING THEN \_\_\_\_\_ CASING TO \_\_\_\_\_ FT. **HOLE NO. PB-1 / PB-1A**

A = AUGER UP = UNDISTURBED PISTON      T = THINWALL      V = VANE TEST

WOR = WEIGHT OF RODS      WOH = WEIGHT OF HAMMER & RODS      C = COARSE

SS = SPLIT TUBE SAMPLER      H.S.A. = HOLLOW STEM AUGER      M = MEDIUM

PROPORTIONS USED: TRACE = 0 - 10%    LITTLE = 10 - 20%    SOME = 20 - 35%    AND = 35 - 50%      F = FINE





<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <u>GNCB Consulting Engineers</u>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <u>G24-1458-20</u>	HOLE NO. <u>PB-3</u>
	PROJECT NAME <u>DEEP MCA Utility</u>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>JK/nk</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE CASING SAMPLER CORE BAR	OFFSET
GROUND WATER OBSERVATIONS AT <u>4</u> ' FT AFTER <u>0</u> HOURS AT <u>  </u> ' FT AFTER <u>  </u> HOURS	SIZE I.D. <u>3 3/4"</u> HAMMER WT. <u>  </u> HAMMER FALL <u>  </u>	DATE START <u>1/27/20</u> DATE FINISH <u>1/27/20</u> SURFACE ELEV. <u>  </u> 362 GROUND WATER ELEV. <u>  </u>

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT					
5								wet		Topsoil DkBrn silty SAND  LtBrn SAND & GRAVEL cobbles, boulders 3'-5'  Brn SAND, silt, gravel  SAME 10'-15'	
10											
15											
17'0"											
20										E.O.B 17'0"	
25										NOTE: Stopped drilling because of nearby electric line.	
30											
35											
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO <u>  </u> FT. USED <u>  </u> CASING THEN <u>  </u> CASING TO <u>  </u> FT.	HOLE NO. <u>PB-3</u>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE





<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-4</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>JK/nk</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b>	SAMPLER <b>SS</b>
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	SIZE I.D. <b>3 3/4"</b>	1 3/8"
AT <u>   </u> FT AFTER <u>   </u> HOURS	HAMMER WT. <b>140#</b>	BIT
	HAMMER FALL <b>30"</b>	363
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					DEPTH @ BOT	BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)				CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	0		6	12	18	MOIST				
5															BkBrn silty SAND, cobbles boulders 1-5'
10															LtBrn FM SAND, lit silt, F gravel 5-10'
15															SAME 10-15'
20															Brn SAND & F GRAVEL 15-20'
25															Brn F SAND 20-25'
30															Brn F SAND 25-30'
35															Brn F SAND 30-35'
35													35'0"		
40															E.O.B 35'0"

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>PB-4</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE	
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-5</b>
FOREMAN - DRILLER <b>MK/ao</b>	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
INSPECTOR <b>Garry Jacobsen</b>	LOCATION <b>Watertown CT</b>	OFFSET
GROUND WATER OBSERVATIONS AT <u>4</u> FT AFTER <u>4</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	TYPE SIZE I.D. HAMMER WT. HAMMER FALL	CASING <b>HSA</b> SAMPLER <b>SS</b> CORE BAR <b>BIT</b> DATE START <b>1/27/20</b> DATE FINISH <b>1/27/20</b> SURFACE ELEV. <b>362</b> GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE				DEPTH @ BOT	BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST MOIST	STRATA CHANGE DEPTH ELEV	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.						
5										Cobbles, boulders 1'-8'	
10										Brn FMC SAND & FC GRAVEL	
15											
20										cobbles, boulders 18'-20'	
25										Brn FMC SAND	
30										SAME	
35											
40										SAME	
45										SAME	
50											
55											
									51'0"	Grey F SAND, sm silt, tr clay, lit FC gravel	
									52'0"	possible weathered BEDROCK Auger refusal	

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. PB-5</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-6</b>
FOREMAN - DRILLER <b>MK/ao</b>	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
INSPECTOR <b>Garry Jacobsen</b>	LOCATION <b>Watertown CT</b>	OFFSET
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>4</u> HOURS	CASING TYPE <b>HSA</b>	DATE START <b>1/27/20</b>
AT <u>   </u> FT AFTER <u>   </u> HOURS	SAMPLER <b>SS</b>	DATE FINISH <b>1/27/20</b>
	SIZE I.D. <b>3 3/4"</b>	SURFACE ELEV. <b>363</b>
	HAMMER WT. <b>140#</b>	GROUND WATER ELEV.
	HAMMER FALL <b>30"</b>	

DEPTH	CASING BLOWS PER FOOT	SAMPLE				DEPTH @ BOT	BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST MOIST	STRATA CHANGE DEPTH ELEV	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC						
5										Brn FMC SAND & FC GRAVEL 1'-7'	
10										sm cobbles	
15										Brn FMC SAND & FC GRAVEL	
20										sm cobbles	
25										Brn FMC SAND & FC GRAVEL	
30										cobbles, boulders 20'-22'	
35										Brn FMC SAND & FC GRAVEL	
40										cobbles	
45										gravel, cobbles	
50									49'0"	possible BEDROCK	
									50'6"	Auger refusal	

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.** **E.O.B 50'6"**

GROUND SURFACE TO <u>   </u> FT. USED <u>   </u> CASING THEN <u>   </u> CASING TO <u>   </u> FT.	HOLE NO. <b>PB-6</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <u>GNCB Consulting Engineers</u>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <u>G24-1458-20</u>	HOLE NO. <u>PB-7</u>
	PROJECT NAME <u>DEEP MCA Utility</u>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>JK/nk</b>	LOCATION <u>Watertown CT</u>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <u>HSA</u>	SAMPLER <u>SS</u>
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	SIZE I.D. <u>3 3/4"</u>	1 <u>3/8"</u>
AT <u>   </u> FT AFTER <u>   </u> HOURS	HAMMER WT. <u>140#</u>	BIT
	HAMMER FALL <u>30"</u>	30"
		DATE START <u>1/27/20</u>
		DATE FINISH <u>1/27/20</u>
		SURFACE ELEV. <u>362</u>
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0-6 6-12 12-18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT					
5										Topsoil DkBrn silty SAND	
										cobbles, boulders 4'-10'	
10										Brn SAND, sm silt, F gravel	
15								wet		Brn SAND & F GRAVEL	
										SAME	
20										SAME	
										SAME	
25										SAME	
										SAME	
30										SAME	
										SAME	
35									35'0"	SAME	
										E.O.B 35'0"	
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <u>PB-7</u>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE	
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>			SHEET <u>1</u> OF <u>1</u> HOLE NO. <b>PB-8</b>		
	PROJECT NO. <b>G24-1458-20</b>			BORING LOCATIONS per Plan		
	PROJECT NAME <b>DEEP MCA Utility</b>					
FOREMAN - DRILLER <b>JK/nk</b>	LOCATION <b>Watertown CT</b>			OFFSET DATE START <b>1/27/20</b> DATE FINISH <b>1/27/20</b> SURFACE ELEV. <b>363</b> GROUND WATER ELEV.		
INSPECTOR <b>Garry Jacobsen</b>	TYPE <b>HSA</b>	CASING <b>3 3/4"</b>	SAMPLER <b>SS</b>			CORE BAR <b>1 3/8"</b>
GROUND WATER OBSERVATIONS AT <u>4</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	SIZE I.D. <b>140#</b>	HAMMER WT. <b>30"</b>	HAMMER FALL <b>BIT</b>			

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT					
5										Topsoil DkBrn silty SAND	
10										Brn F SAND, sm silt, F gravel cobbles, boulders 1-7' Brn F SAND 5-10'	
15										SAME 10-15'	
20										SAME 15-20'	
25										SAME 20-25'	
30										SAME 25-30'	
35									35'0"	SAME 30-35'	
40										E.O.B 35'0"	

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. PB-8</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50% F = FINE	



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-9 / PB-9A / PB-9B</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>MK/ao</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE	CASING HSA SAMPLER SS CORE BAR
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>   </u> FT AFTER <u>   </u> HOURS	SIZE I.D. <b>3 3/4"</b>	DATE START <b>1/27/20</b>
	HAMMER WT. <b>140#</b>	DATE FINISH <b>1/28/20</b>
	HAMMER FALL <b>30"</b>	SURFACE ELEV. <b>361.5</b>
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT					
	<b>PB-9</b>									6" Topsoil BlkBrn F SAND, sm silt	
5										cobbles, boulders from 7'	
10									9'6"	Auger refusal	
										Offset 5' to PB-9A	
	<b>PB-9A</b>									<b>PB-9A</b>	
5										cobbles, boulders	
10									9'6"	Auger refusal	
										Offset 5' to PB-9B	
0	<b>PB-9B</b>									<b>PB-9B</b>	
5										cobbles, boulder	
									6'6"	Auger refusal	
10											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO \_\_\_\_\_ FT. USED \_\_\_\_\_ CASING THEN \_\_\_\_\_ CASING TO \_\_\_\_\_ FT. HOLE NO. **PB-9 / PB-9A / PB-9B**

A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST

WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE

SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM

PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50% F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u> HOLE NO. <b>PB-9C</b>
	PROJECT NO. <b>G24-1458-20</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>MK/ao</b>	PROJECT NAME <b>DEEP MCA Utility</b>	LOCATION <b>Watertown CT</b>
INSPECTOR <b>Garry Jacobsen</b>	TYPE SIZE I.D.	CASING HSA
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	SAMPLER SS	CORE BAR BIT
	HAMMER WT. HAMMER FALL	140# 30"
		OFFSET DATE START <b>1/27/20</b> DATE FINISH <b>1/28/20</b> SURFACE ELEV. <b>361.5</b> GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE				DEPTH @ BOT	BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE)			CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC		0	6	12				
5													
10													cobbles, boulders 6'6"-10'
15													
20													Brn FMC SAND & FC GRAVEL to 43'0"
25													
30													
35													
40													
45													cobbles, boulders from 43'0"
50											49'0"		possible BEDROCK
55											55'6"		Auger refusal

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. PB-9C</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50% F = FINE	



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	PROJECT NO. <b>G24-1458-20</b>	
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>MK/ao</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE	OFFSET
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	CASING <b>NW</b>	SAMPLER <b>SS</b>
	SIZE I.D. <b>3"</b>	CORE BAR <b>NQ2</b>
	HAMMER WT. <b>140#</b>	DATE START <b>1/29/20</b>
	HAMMER FALL <b>30"</b>	DATE FINISH <b>1/30/20</b>
		SURFACE ELEV. <b>361</b>
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST MOIST	STRATA CHANGE DEPTH ELEV	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT					
5										Brn FMC SAND & FC GRAVEL, cobbles	
10										cobbles to 15'	
15										FMC SAND	
20											
25									25'6"	Casing refusal	
		1	C	60"	60"	30'5"	RQD= 72%				
								5			
								5			
								4			
30								4			
								4			
									30'5"		
35										E.O.B 30'5"	
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>PB-10</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE	
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-11</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>JK/nk</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b>	SAMPLER <b>SS</b>
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	SIZE I.D. <b>3 3/4"</b>	1 <b>3/8"</b>
AT <u>   </u> FT AFTER <u>   </u> HOURS	HAMMER WT. <b>140#</b>	BIT
	HAMMER FALL <b>30"</b>	GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT					
5										Topsoil DkBrn silty SAND	
										Brn SAND, sm silt, F gravel 1-5'	
10										Brn SAND, & F GRAVEL 5-10'	
										SAME 10-15'; cobbles,	
15										SAME 15-20', cobbles	
										SAME 20-25', cobbles	
25										SAME 25-30' cobbles	
										SAME 30-35'	
35									35'0"		
										E.O.B 35'0"	
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO <u>   </u> FT. USED <u>   </u> CASING THEN <u>   </u> CASING TO <u>   </u> FT.	HOLE NO. <b>PB-11</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE	
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-12</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>JK/nk</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b>	OFFSET DATE START <b>1/28/20</b>
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	SAMPLER SS	DATE FINISH <b>1/28/20</b>
	CORE BAR BIT	SURFACE ELEV. <b>361</b>
	SIZE I.D. <b>3 3/4"</b>	GROUND WATER ELEV.
	HAMMER WT. <b>140#</b>	
	HAMMER FALL <b>30"</b>	

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST MOIST	STRATA CHANGE DEPTH ELEV	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT					
5										SAND, cobbles, boulders 1-8'	
10		1	C	60"	36"	13'0"	RQD= 20%	3	8'0"	Auger refusal	
								4		GNEISS (BEDROCK)	
								3			
								4			
								3	13'0"		
15										E.O.B 13'0"	
20											
25											
30											
35											
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. PB-12</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-13</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>MK/ao</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE CASING SAMPLER CORE BAR	OFFSET DATE START DATE FINISH SURFACE ELEV. GROUND WATER ELEV.
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	SIZE I.D. HAMMER WT. HAMMER FALL	385
	HSA 3 3/4" 140# 30"	SS 1 3/8" BIT DIA
	SS nq2 2"	1/29/20 1/29/20

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST MOIST	STRATA CHANGE DEPTH ELEV	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT					
5											Brn FMC SAND & FC GRAVEL, sm cobbles
10									10'0"		Auger refusal
		1	C	60"	54"	15'0"	RQD= 60%	5			
								4			
								4			
								4			
15								4	15'0"		GNEISS & SCHIST BEDROCK
20											E.O.B 15'0"
25											
30											
35											
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. PB-13</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-14A</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>JK/nk</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b>	SAMPLER <b>SS</b>
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	SIZE I.D. <b>3 3/4"</b>	1 <b>3/8"</b>
AT <u>   </u> FT AFTER <u>   </u> HOURS	HAMMER WT. <b>140#</b>	BIT
	HAMMER FALL <b>30"</b>	GROUND WATER ELEV. <b>355</b>

H I G H T	C A S I N G B L O W S P E R F O O T	S A M P L E					B L O W S P E R 6 I N O N S A M P L E ( F O R C E O N T U B E ) 0 - 6 6 - 12 12 - 18	C O R E T I M E P E R F T ( M I N )	D E N S I T Y O R C O N S I S T  M O I S T	S T R A T A C H A N G E D E P T H  E L E V	F I E L D I D E N T I F I C A T I O N O F S O I L R E M A R K S I N C L. C O L O R, L O S S O F W A S H W A T E R, S E A M S I N R O C K, E T C.
		N O	T Y P E	P E N	R E C.	D E P T H @ B O T					
5										4'6"	cobbles, boulders 1-4'6"  Auger refusal
		1	C	60"	49"	9'6"	RQD= 47%	3			GNEISS
								4			BEDROCK
10								3		9'6"	
15											E.O.B 9'6"
20											NOTE: initially drilled 5 ft. South at location PB-14, then relocated to PB-14A
25											
30											
35											
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	<b>HOLE NO. PB-14A</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-15</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>MK/ao</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE <b>HSA</b> CASING <b>SS</b> SAMPLER <b>SS</b> CORE BAR	OFFSET
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	SIZE I.D. <b>3 3/4"</b>	DATE START <b>1/29/20</b>
AT <u>   </u> FT AFTER <u>   </u> HOURS	HAMMER WT. <b>140#</b> BIT	DATE FINISH <b>1/29/20</b>
	HAMMER FALL <b>30"</b>	SURFACE ELEV. <b>384</b>
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT					
5								v loose		5" Asphalt Brn FM SAND, lit FC gravel	
										OrgBrn F SAND, lit silt, tr FC gravel	
10										Brn FMC SAND, sm FC gravel, lit cobbles	
										Brn FMC SAND & FC GRAVEL, cobbles, boulders	
15											
20											
									22'6"		
									23'0"	possible BEDROCK Auger refusal	
25											
30											
35											
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>PB-15</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE	
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE



<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-16</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>MK/ao</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	TYPE	CASING
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS AT <u>  </u> FT AFTER <u>  </u> HOURS	SIZE I.D.	SAMPLER
	HAMMER WT.	CORE BAR
	HAMMER FALL	OFFSET
		DATE START
		DATE FINISH
		SURFACE ELEV.
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC.	DEPTH @ BOT					
		1	C	60	50"	6'0"	RQD= 23%	6		1'0"	Brn FMC SAND, sm FC gravel Auger refusal
								6			GNEISS
5								5			BEDROCK
								4			
								4		6'0"	
10											E.O.B 6'0"
15											
20											
25											
30											
35											
40											

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>PB-16</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS	C = COARSE
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER	M = MEDIUM
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50%	F = FINE

<b>SOILTESTING, INC.</b> 90 DONOVAN RD. OXFORD, CT 06478 CT (203) 262-9328 NY (914) 946-4850	CLIENT: <b>GNCB Consulting Engineers</b>	SHEET <u>1</u> OF <u>1</u>
	PROJECT NO. <b>G24-1458-20</b>	HOLE NO. <b>PB-17/PB-17A/PB17B</b>
	PROJECT NAME <b>DEEP MCA Utility</b>	BORING LOCATIONS per Plan
FOREMAN - DRILLER <b>MK/ao</b>	LOCATION <b>Watertown CT</b>	
INSPECTOR <b>Garry Jacobsen</b>	CASING TYPE <b>HSA</b>	SAMPLER <b>SS</b>
GROUND WATER OBSERVATIONS AT <u>none</u> FT AFTER <u>0</u> HOURS	SIZE I.D. <b>3 3/4"</b>	DATE START <b>1/30/20</b>
AT <u> </u> FT AFTER <u> </u> HOURS	HAMMER WT. <b>140#</b>	DATE FINISH <b>1/30/20</b>
	HAMMER FALL <b>30"</b>	SURFACE ELEV. <b>362</b>
		GROUND WATER ELEV.

DEPTH	CASING BLOWS PER FOOT	SAMPLE					BLOWS PER 6 IN ON SAMPLER (FORCE ON TUBE) 0 - 6 6 - 12 12 - 18	CORE TIME PER FT (MIN)	DENSITY OR CONSIST	STRATA CHANGE DEPTH	FIELD IDENTIFICATION OF SOIL REMARKS INCL. COLOR, LOSS OF WASH WATER, SEAMS IN ROCK, ETC.
		NO	Type	PEN	REC	DEPTH @ BOT					
5	PB-17									4'0"	Blk F SAND, lit silt, sm F gravel
										8'0"	cobbles, boulders
											Auger refusal
											Offset 5' to PB-17A
5	PB-17A									4'0"	Blk F SAND, lit silt, sm F gravel
										8'0"	cobbles, boulders
											Auger refusal
											Offset 5' to PB-17B
5	PB-17B									4'0"	Blk F SAND, lit silt, sm F gravel
											cobbles, boulders to 10'0"
											Brm FMC SAND & FC GRAVEL
										28'0"	Auger refusal

**NOTE: Subsoil conditions revealed by this investigation represent conditions at specific locations and may not represent conditions at other locations or times.**

GROUND SURFACE TO _____ FT. USED _____ CASING THEN _____ CASING TO _____ FT.	HOLE NO. <b>PB-17/PB-17A/PB17B</b>
A = AUGER UP = UNDISTURBED PISTON T = THINWALL V = VANE TEST	
WOR = WEIGHT OF RODS WOH = WEIGHT OF HAMMER & RODS C = COARSE	
SS = SPLIT TUBE SAMPLER H.S.A. = HOLLOW STEM AUGER M = MEDIUM	
PROPORTIONS USED: TRACE = 0 - 10% LITTLE = 10 - 20% SOME = 20 - 35% AND = 35 - 50% F = FINE	





PB-16	C1	10'-6.0'	Rec. 50%/53%	RQD 15"/23%	BDE	
PB-13	C1	10'-15'	Rec. 54%/90%	RQP 36'/60%	BAE	





## **Appendix B: Results of Laboratory Rock Tests**





Client:	GNCB Consulting Engineers, P.C.		
Project:	Deep W. Dist. A Headwaters		
Location:	Watertown, CT	Project No:	GTX-311276
Boring ID:	---	Sample Type:	---
Sample ID:	---	Test Date:	02/07/20
Depth :	---	Test Id:	543136
		Tested By:	tIm
		Checked By:	smd

## Mohs Hardness Test

Boring ID	Sample ID	Depth	Scale of Hardness Number
PB10	C1	28.3-28.9	7.5
PB12	C1	8.6-9.2	3.5
PB14A	C1	4.7-5.5	7.5
PB16	C1	1.8-2.4	7.5

Notes: The value listed above is an estimate of the hardness of the rock sample provided using the Mohs Hardness method. This method is intended to represent the hardness of individual minerals not rock hardness

Tests performed on cut surface of rock core samples provided by client.

<u>Mohs Table of Hardness Scale</u>			
1	Talc	6	Orthoclase
2	Gypsum	7	Quartz
3	Calcite	8	Topaz
4	Fluorite	9	Corundum
5	Apatite	10	Diamond



Client:	GNCB Consulting Engineers, P.C.		
Project:	Deep W. Dist. A Headwaters		
Location:	Watertown, CT	Project No:	GTX-311276
Boring ID:	---	Sample Type:	---
Sample ID:	---	Test Date:	02/10/20
Depth :	---	Tested By:	tIm
		Checked By:	jsc
		Test Id:	543132

## Bulk Density and Compressive Strength of Rock Core Specimens by ASTM D7012 Method C

Boring ID	Sample Number	Depth	Bulk Density, pcf	Compressive strength, psi	Failure Type	Meets ASTM D4543	Note(s)
PB10	C1	28.3-28.9 ft	166	16650	1	Yes	---
PB12	C1	8.6-9.2 ft	188	24146	1	Yes	---
PB14A	C1	4.7-5.5 ft	166	15639	1	Yes	---
PB16	C1	1.8-2.4	168	13957	1	No	3,*

- Notes: Density determined on core samples by measuring dimensions and weight and then calculating.  
 All specimens tested at the approximate as-received moisture content and at standard laboratory temperature.  
 The axial load was applied continuously at a stress rate that produced failure in a test time between 2 and 15 minutes.  
 Failure Type: 1 = Intact Material Failure; 2 = Discontinuity Failure; 3 = Intact Material and Discontinuity Failure  
 (See attached photographs)
- 1: Best effort end preparation. See Tolerance report for details.
  - 2: The as-received core did not meet the ASTM side straightness tolerance due to irregularities in the sample as cored.
  - 3: Specimen L/D < 2.
  - 4: The as-received core did not meet the ASTM minimum diameter tolerance of 1.875 inches.
  - 5: Specimen diameter is less than 10 times maximum particle size.
  - 6: Specimen diameter is less than 6 times maximum particle size.

\*Because the indicated tested specimens did not meet the ASTM D4543 standard tolerances, the results reported here may differ from those for a test specimen within tolerances.







Client:	GNCB Consulting Engineers, P.C.
Project Name:	Deep W. Dist. A Headwaters
Project Location:	Watertown, CT
GTX #:	311276
Test Date:	2/7/2020
Tested By:	cmh
Checked By:	jsc
Boring ID:	PB10
Sample ID:	C1
Depth:	28.3-28.9



After cutting and grinding



After break

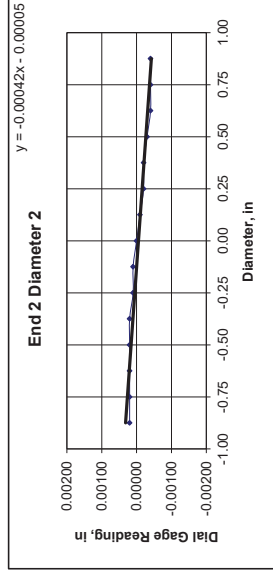
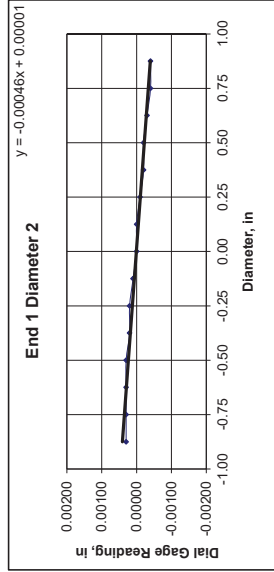
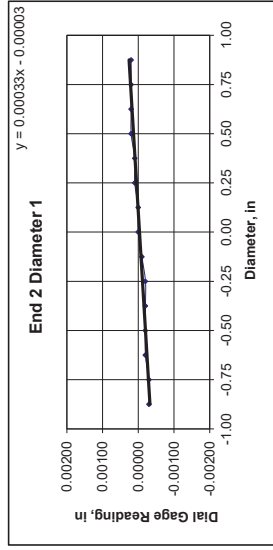
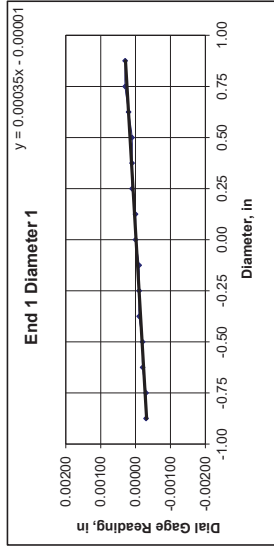


Client: GNCB Consulting Engineers, P.C.  
 Project Name: Deep W. Dist. A Headwaters  
 Project Location: Watertown, CT  
 GTX #: 311276  
 Boring ID: PB12  
 Sample ID: C1  
 Depth: 8.6-9.2 ft  
 Visual Description: See photographs

Test Date: 2/4/2020  
 Tested By: cmh  
 Checked By: jsc

## UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY		DEVIATION FROM STRAIGHTNESS (Procedure S1)															
		Minimum Diameter Tolerance Met? <span style="color: green;">YES</span>					Length to Diameter Ratio Tolerance Met? <span style="color: green;">YES</span>										
Specimen Length, in:	4.58	Average										Maximum gap between side of core and reference surface plate: Is the maximum gap $\leq 0.02$ in.? <span style="color: green;">YES</span>					
Specimen Diameter, in:	1.98	4.58										Maximum difference must be $< 0.020$ in. <b>Straightness Tolerance Met?</b> <span style="color: green;">YES</span>					
Specimen Mass, g:	696.89	1.98															
Bulk Density, lb/ft <sup>3</sup> :	188	0.00000															
Length to Diameter Ratio:	2.3	0.00000															
<b>END FLATNESS AND PARALLELISM (Procedure FP1)</b>																	
END 1	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875		
Diameter 1, in	-0.00030	-0.00030	-0.00030	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00030	0.00030		
Diameter 2, in (rotated 90°)	0.00030	0.00030	0.00030	0.00030	0.00020	0.00020	0.00000	0.00000	0.00000	-0.00010	-0.00010	-0.00020	-0.00020	-0.00030	-0.00040		
END 2	-0.875	-0.750	-0.625	-0.500	-0.375	-0.250	-0.125	0.000	0.125	0.250	0.375	0.500	0.625	0.750	0.875		
Diameter 1, in	-0.00030	-0.00030	-0.00020	-0.00020	-0.00020	-0.00010	-0.00010	0.00000	0.00000	0.00010	0.00010	0.00020	0.00020	0.00020	0.00020		
Diameter 2, in (rotated 90°)	0.00020	0.00020	0.00020	0.00020	0.00020	0.00010	0.00010	0.00000	0.00000	-0.00010	-0.00020	-0.00020	-0.00040	-0.00040	-0.00040		
Difference between max and min readings, in:												0° = 0.00060		90° = 0.00070			
Maximum difference must be $< 0.0020$ in.												Difference = $\pm 0.00035$		<b>Flatness Tolerance Met?</b> <span style="color: green;">YES</span>			



DIAMETER 1		DIAMETER 2	
End 1:	Slope of Best Fit Line: 0.00035 Angle of Best Fit Line: 0.01981	End 1:	Slope of Best Fit Line: 0.00046 Angle of Best Fit Line: 0.02619
End 2:	Slope of Best Fit Line: 0.00033 Angle of Best Fit Line: 0.01915	End 2:	Slope of Best Fit Line: 0.00042 Angle of Best Fit Line: 0.02423
Maximum Angular Difference: 0.00065		Maximum Angular Difference: 0.00196	
<b>Parallelism Tolerance Met?</b> Spherically Seated: <span style="color: green;">YES</span>		<b>Parallelism Tolerance Met?</b> Spherically Seated: <span style="color: green;">YES</span>	

PERPENDICULARITY (Procedure P1)			
(Calculated from End Flatness and Parallelism measurements above)			
END 1	Diameter 1, in	Diameter 2, in (rotated 90°)	Perpendicularity Tolerance Met?
	1.980	1.980	YES
	0.00060	0.00070	YES
	0.00030	0.00035	0.017
	0.00030	0.00035	0.020
END 2	Diameter 1, in	Diameter 2, in (rotated 90°)	Perpendicularity Tolerance Met?
	1.980	1.980	YES
	0.00050	0.00060	YES
	0.00025	0.00030	0.014
	0.00030	0.00030	0.017



Client:	GNCB Consulting Engineers, P.C.
Project Name:	Deep W. Dist. A Headwaters
Project Location:	Watertown, CT
GTX #:	311276
Test Date:	2/7/2020
Tested By:	cmh
Checked By:	jsc
Boring ID:	PB12
Sample ID:	C1
Depth:	8.6-9.2



After cutting and grinding



After break







Client:	GNCB Consulting Engineers, P.C.
Project Name:	Deep W. Dist. A Headwaters
Project Location:	Watertown, CT
GTX #:	311276
Test Date:	2/7/2020
Tested By:	cmh
Checked By:	jsc
Boring ID:	PB14A
Sample ID:	C1
Depth:	4.7-5.5



After cutting and grinding



After break



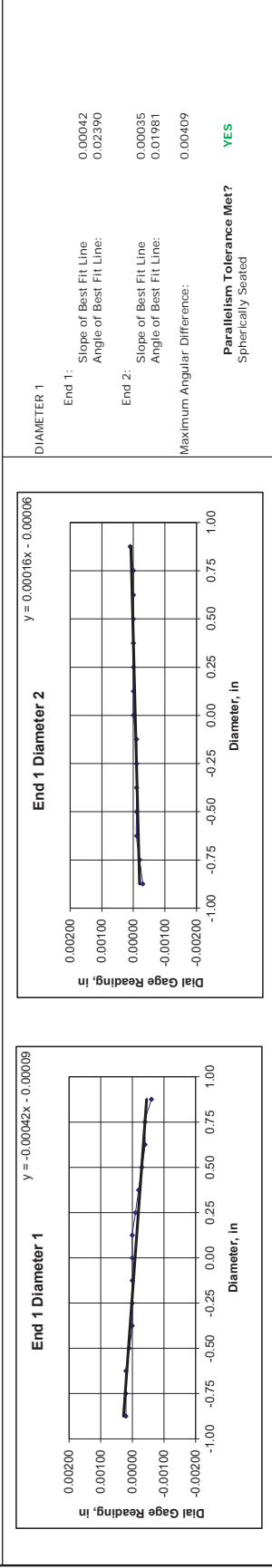
Client: GNCE Consulting Engineers, P.C.  
 Project Name: Deep W. Dist. A. Headwaters  
 Project Location: Watertown, CT  
 GTX #: 311276  
 Boring ID: PB16  
 Sample ID: C1  
 Depth: 1.8-2.4 ft  
 Visual Description: See photographs

Test Date: 2/10/2020  
 Tested By: cmh/kcp  
 Checked By: jsc

## UNIT WEIGHT DETERMINATION AND DIMENSIONAL AND SHAPE TOLERANCES OF ROCK CORE SPECIMENS BY ASTM D4543

BULK DENSITY		Average	
Specimen Length, in:	2	2.78	1.99
Specimen Diameter, in:	1.99	1.99	1.99
Specimen Mass, g:	380.18		
Bulk Density, lb/ft <sup>3</sup> :	168		
Length to Diameter Ratio:	1.4		

END FLATNESS AND PARALLELISM (Procedure FP1)		Minimum Diameter Tolerance Met?		Length to Diameter Ratio Tolerance Met?		Straightness Tolerance Met?	
END 1		YES	NO				YES
Diameter 1, in	-0.875	-0.500	-0.125	0.0000	0.0000	0.375	0.625
Diameter 2, in (rotated 90°)	0.00020	0.00010	0.00000	0.00000	0.00000	-0.00020	-0.00040
Diameter 1, in	-0.750	-0.500	-0.125	0.0000	0.0000	0.00000	0.00040
Diameter 2, in (rotated 90°)	0.00010	0.00010	0.00010	0.00000	0.00000	0.00000	0.00040



DIAMETER 1		DIAMETER 2	
End 1:	Slope of Best Fit Line: 0.00042 Angle of Best Fit Line: 0.02390	End 1:	Slope of Best Fit Line: 0.00016 Angle of Best Fit Line: 0.00900
End 2:	Slope of Best Fit Line: 0.00035 Angle of Best Fit Line: 0.01981	End 2:	Slope of Best Fit Line: 0.00011 Angle of Best Fit Line: 0.00638
Maximum Angular Difference:	0.00409	Maximum Angular Difference:	0.00262
<b>Parallelism Tolerance Met?</b> Spherically Seated		<b>Parallelism Tolerance Met?</b> Spherically Seated	
<b>YES</b>		<b>YES</b>	

PERPENDICULARITY (Procedure P1)		PERPENDICULARITY TOLERANCE MET?	
END 1	(Calculated from End Flatness and Parallelism measurements above)	Maximum angle of departure must be ≤ 0.25°	
Diameter 1, in	Difference, Maximum and Minimum (in.): 0.00080	Perpendicularity Tolerance Met?	YES
Diameter 2, in (rotated 90°)	Diameter (in.): 1.990		YES
END 2			YES
Diameter 1, in	Diameter (in.): 1.990		YES
Diameter 2, in (rotated 90°)	Diameter (in.): 1.990		YES



Client:	GNCB Consulting Engineers, P.C.
Project Name:	Deep W. Dist. A Headwaters
Project Location:	Watertown, CT
GTX #:	311276
Test Date:	2/10/2020
Tested By:	cmh/kdp
Checked By:	jsc
Boring ID:	PB16
Sample ID:	C1
Depth, ft:	1.8-2.4



After cutting and grinding



After break

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# **Section 50 50 00 Elevator Agreement**

### ELEVATOR AGREEMENT

It is hereby agreed on this \_\_\_\_ day of \_\_\_\_, \_\_\_\_ between the State of Connecticut, Department of Administrative Services acting through its Commissioner, \_\_\_\_\_ and \_\_\_\_\_ acting through \_\_\_\_\_ its \_\_\_\_\_ that:

WHEREAS, the State of Connecticut owns several buildings which contain elevators manufactured by \_\_\_\_\_;

WHEREAS, \_\_\_\_\_ Provides a diagnostic device required for the complete service and maintenance of the elevators which diagnostic device has a six (6) month expiration date;

WHEREAS, the State of Connecticut retains several contractors and/or uses its own employees to service the \_\_\_\_\_ elevators;

WHEREAS, the State of Connecticut finds any expiration period an excessive burden on the service and maintenance of the elevators;

NOW, THEREFORE, for good and sufficient consideration of \$1.00 (one dollar) the parties agree as follows:

1. \_\_\_\_\_ shall provide the State of Connecticut with the proper diagnostic devices to service all \_\_\_\_\_, Inc. elevators in all state buildings at no cost to the State of Connecticut.
2. The diagnostic devices shall not contain an expiration date or the use of any proprietary restraint and will be capable of servicing and maintaining the elevators for their life.
3. In the event \_\_\_\_\_ deems it necessary to update the diagnostic devices it shall exchange such devices at no cost to the State of Connecticut. The updated diagnostic devices shall not contain an expiration date and will be capable of servicing and maintaining the elevators for their life. This upgrade will occur prior to previous tools date of expiration.
4. All employees of the State of Connecticut duly qualified or licensed and any contractors retained by the State of Connecticut to service and/or maintain the \_\_\_\_\_ elevators shall use the diagnostic devices solely for the purpose of conducting normal service and maintenance activities.
5. All employees of the State of Connecticut duly qualified or licensed and any contractors retained by the State of Connecticut to service and/or maintain the \_\_\_\_\_ elevators shall not themselves or otherwise give, lend, sell, advertise, transfer or permit access to or the use of the diagnostic devices, in part or whole, in any manner by any means, by any other person.
6. The State of Connecticut understands that the diagnostic devices are capable of programming and/or reprogramming critical equipment, operating performance functions and reprogramming critical equipment functions and parameters including safety and/or test sequences. Improper use may produce unsafe operating conditions.
7. The State of Connecticut agrees that \_\_\_\_\_ is not responsible for the results of the improper use, either directly or indirectly, of the diagnostic devices, unless the device is defective.
8. The State of Connecticut agrees to make all reasonable efforts necessary or appropriate to maintain and protect the diagnostic devices and shall promptly notify \_\_\_\_\_ in writing, of any unauthorized use, possession, loss or theft of the diagnostic devices in part or whole.
9. This Agreement shall be interpreted and enforced pursuant to the laws of the State of Connecticut in the Superior Court for the Judicial District of Hartford, at Hartford, Connecticut.

\_\_\_\_\_  
Witness

\_\_\_\_\_  
Witness

\_\_\_\_\_  
Witness

\_\_\_\_\_  
Witness

\_\_\_\_\_  
[insert name of Commissioner]

Commissioner,  
State of Connecticut  
Department of Administrative Services

\_\_\_\_\_  
[insert name of signer and title]

[insert name of Elevator Manufacturer]

[insert address of Elevator Manufacturer]

End of Section 50 50 00 Elevator Agreement

# **Section 50 60 00 FM Global Checklist for Roofing Systems**

## SAMPLE FM GLOBAL CHECKLIST FOR ROOFING SYSTEMS – page 1

### CHECKLIST FOR ROOFING SYSTEM



*FM Global Clients: submit completed form and completed RoofNav Contractor Package to local FM Global field office for review.*

CONTACT INFORMATION:	FM GLOBAL INDEX NUMBER:	
ROOFING CONTRACTOR (NAME, ADDRESS, PROJECT NO.)	TELEPHONE NO.:	CONTACT:
	E-MAIL ADDRESS:	FAX:
CLIENT SITE (NAME & ADDRESS)	TELEPHONE NO.:	CONTACT:
	E-MAIL ADDRESS:	FAX:

**OVERVIEW OF WORK:** *(Submit 1 form per roof area)*

Building Name & Number (provide building diagram as appropriate):			
Type of Work: <input type="checkbox"/> New Construction <input type="checkbox"/> Recover (New roof over existing Roofing System)			
<input type="checkbox"/> Reroof (New cover/remove existing roofing system to deck) <input type="checkbox"/> Other (describe)			
Building Dimensions: Length:	ft/m;	Width:	ft/m;
Roof Slope:	in. per ft. / degrees	Height	ft/m.
Parapet Height .max (in./m):		Parapet Height .min (in./m):	<i>(put "0" if not always present)</i>
Roof Zone Width/Dimension*:			
Zone 1':	Zone 1:	Zone 2:	Zone 3:
FM Approved RoofNav Assembly Numbers <i>(provide Assembly Number for individual roof zones as appropriate):</i>			

\*Refer to FM Global Property Loss Prevention Data Sheet 1-28, *Wind Design* or RoofNav for determination of various zone dimensions.

**ROOF SURFACING:**

<input type="checkbox"/> None			
<input type="checkbox"/> Coating	<i>(Trade Name/Application Rate)</i>		
<input type="checkbox"/> Granules	<i>(Application Rate)</i>		
<input type="checkbox"/> Gravel/Slag	<i>(Application Rate)</i>		
<input type="checkbox"/> Ballast:	<input type="checkbox"/> Stone Size	<input type="checkbox"/> Pavers	<i>(Beveled, strapped or square edge);</i> <input type="checkbox"/> Other:
Ballast Weight (psf):	Zone 1':	Zone 2:	Zone 3:
Additional Detail:			

**ROOF COVER / MEMBRANE:**  
*(Provide ALL applicable details including trade name, type, number of plies, thickness, reinforced, adhesive, etc.)*

Roof Cover: Trade Name:			
Hail Rating Provided:			
<input type="checkbox"/> Single Ply:	<input type="checkbox"/> Adhered	<input type="checkbox"/> Fastened	<input type="checkbox"/> Ballasted
<input type="checkbox"/> Multi-Ply	Built Up Roofing (BUR)	<input type="checkbox"/> Modified Bitumen	
Number of Plies:			
<input type="checkbox"/> Lap Width	in/mm	<input type="checkbox"/> Lap Adhesion Type	
<input type="checkbox"/> Panel:	<input type="checkbox"/> Through Fastened Metal <input type="checkbox"/> Standing Seam metal <input type="checkbox"/> Fiber Reinforced Plastic (FRP) <input type="checkbox"/> Other:		
<input type="checkbox"/> Spray Applied	<input type="checkbox"/> Other:		
Additional Detail:			

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**SAMPLE FM GLOBAL CHECKLIST FOR ROOFING SYSTEMS – page 2**

**CHECKLIST FOR ROOFING SYSTEM**



**ROOF COVER / MEMBRANE SECUREMENT:**

Roof Cover Fasteners: Trade Name:	Length:	Diameter/No.:
Stress Plate/Batten: Trade Name:	Size:	
Row Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Fastener Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Bonding Adhesive: Trade Name:		
Adhesive Ribbon Width (in.):		
Adhesive Ribbon Spacing (in.): Zone 1':	Zone 1:	Zone 2: Zone 3:
Adhesive Application Rate (gal./sq.):		
Additional Detail:		

**INSULATION / COVER BOARD:**

Layer	Insulation / Cover Board Trade Name	Board Dimensions (ft. x. ft.)	Thickness (in.)	Fastened	Adhered	Tapered
1. Top		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Next		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. Thermal Barrier		X		<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
<input type="checkbox"/> Glass Fiber/Mineral Wool/Batt		<input type="checkbox"/> Facer Type/Vapor Barrier				
<input type="checkbox"/> Other:						
<input type="checkbox"/> None						
Additional Detail:						

**INSULATION / COVER BOARD SECUREMENT:**

Insulation / Cover Board Fasteners: Trade Name:	Type:	Size:
Stress Plate: Trade Name:	Size:	
Fastener Spacing: Zone 1':	Zone 1:	Zone 2: Zone 3:
Bonding Adhesive: Trade Name:		
Adhesive Ribbon Width (in.):		
Adhesive Ribbon Spacing (in.): Zone 1':	Zone 1:	Zone 2: Zone 3:
Adhesive Application Rate (gal./sq.):		
Additional Detail:		

**BASE SHEET: (Include Trade Name, Type, and Width)**

<input type="checkbox"/> None	
Trade Name:	Width: <input type="checkbox"/> 36 in. <input type="checkbox"/> 1 meter (39 in.)
<input type="checkbox"/> Fastened	<input type="checkbox"/> Adhered
<input type="checkbox"/> Lap Width in/mm	<input type="checkbox"/> Lap Adhesion Type
<input type="checkbox"/> Air Retarder	<input type="checkbox"/> Vapor Retarder
Additional Detail:	

**BASE SHEET SECUREMENT:**

Base Sheet Adhesive Name:	Adhesive Application Rate:
Base Sheet Fastener Trade Name:	Type:
Head Diameter:	Length:
Spacing: (Attached Sketches as necessary)	
Spacing Along Laps: Zone 1':	Zone 1: Zone 2: Zone 3:
No. Intermediate Rows: Zone 1':	Zone 1: Zone 2: Zone 3:
Spacing Along Intermediate Rows: Zone 1':	Zone 1: Zone 2: Zone 3:
Additional Detail:	

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**SAMPLE FM GLOBAL CHECKLIST FOR ROOFING SYSTEMS – page 3**

**CHECKLIST FOR ROOFING SYSTEM**



**DECK:**

<input type="checkbox"/> Steel:	Manufacturer:	Type (e.g. wide rib):	Thickness / Gauge:	Yield Strength:
<input type="checkbox"/> LWIC (Form Deck):	<input type="checkbox"/> Cementitious Wood Fiber (Pullout Test Required):			
<input type="checkbox"/> Concrete:	<input type="checkbox"/> Pre-cast panels or <input type="checkbox"/> Cast in Place			
<input type="checkbox"/> Wood (Pullout Test Required):				
<input type="checkbox"/> Fiber Reinforced Cement:	<input type="checkbox"/> Fiber Reinforced Plastic			
<input type="checkbox"/> Gypsum (Pullout Test Required):	<input type="checkbox"/> Plank or <input type="checkbox"/> Poured			
<input type="checkbox"/> Other:				
Additional Detail:				

**DECK or ROOF PANEL SECUREMENT:**

Deck Or Roof Panel Fasteners:		Type:		
Trade Name:		Size Washer:		
Length:	Washer:			
If Weld:	Size:	Weld:	Washer:	
Fastener / Weld Spacing:	Zone 1:	Zone 1:	Zone 2:	Zone 3:
Deck Side Lap Fastener Spacing:	Zone 1:	Zone 1:	Zone 2:	Zone 3:
Additional Detail:				

**ROOF STRUCTURE (Include Size, Gage, Etc.):**

<input type="checkbox"/> Purlins	<input type="checkbox"/> "C" or <input type="checkbox"/> "Z"	Thickness:		
Purlin:	Zone 1:	Zone 2:	Zone 3:	
<input type="checkbox"/> Joists	<input type="checkbox"/> Wood or <input type="checkbox"/> Steel			
Joist Spacing:	Zone 1:	Zone 2:	Zone 3:	
<input type="checkbox"/> Beams	<input type="checkbox"/> Wood or <input type="checkbox"/> Steel			
Beam Spacing:	Zone 1:	Zone 2:	Zone 3:	
<input type="checkbox"/> Other:				
Additional Detail:				

**PERIMETER FLASHING: (Attach a detailed sketch of metal fascia, gravel stop, nailer, blocking, coping, etc.)**

<input type="checkbox"/> FM Approved Flashing				
<input type="checkbox"/> Other (applicable only when FM Approved system is not available):				
Manufacturer/Trade Name:				
Flashing Max Wind Rating:				
Fascia / Coping Detail:	Face Height:	Thickness:		
Hook Strip Detail:	Height:	Thickness:	Fastener spacing:	
Nailer / Blocking Details Per FM Global Data Sheet 1-49? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach Details)				
Nailer Securement:	Diameter:	Spacing:	Embedment:	
Additional Detail:				

**DRAINAGE:**

For new construction: Has roof drainage been designed by a Qualified Engineer per FM Global Loss Prevention Data Sheet 1-54 and the local building code? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details)	
For re-roofing and recovering: will the roof drainage be changed from the original design (i.e. drains inserted/covered/removed, new expansion joints, blocked or reduced scupper size)? <input type="checkbox"/> Yes <input type="checkbox"/> No	
If yes, were the changes reviewed by a Qualified Engineer? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details)	
Is secondary (emergency) roof drainage provided per FM Global Data Sheet 1-54? <input type="checkbox"/> Yes <input type="checkbox"/> No (Attach details)	
Additional Detail:	

**ROOF MOUNTED EQUIPMENT: (Attach drawings, calculations and any supporting detail.)**

Roof mounted equipment secured per FM Global Loss Prevention Data Sheet 1-28 and the local building code? <input type="checkbox"/> Yes <input type="checkbox"/> No
Additional Detail:

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End of Section 50 60 00 FM Global Checklist for Roofing Systems

# **Section 50 70 00**

## **Statement of Special Inspections**







## Schedule of Inspection and Testing Agencies

This Statement of Special Inspections / Quality Assurance Plan includes the following building systems:

- |   |  |
|---|--|
| <input checked="" type="checkbox"/> Soils and Foundations     | <input type="checkbox"/> Spray Fire Resistant Material         |
| <input checked="" type="checkbox"/> Cast-in-Place Concrete    | <input checked="" type="checkbox"/> Wood Construction          |
| <input type="checkbox"/> Precast Concrete                     | <input type="checkbox"/> Exterior Insulation and Finish System |
| <input checked="" type="checkbox"/> Masonry                   | <input type="checkbox"/> Mechanical & Electrical Systems       |
| <input checked="" type="checkbox"/> Structural Steel          | <input type="checkbox"/> Architectural Systems                 |
| <input checked="" type="checkbox"/> Cold-Formed Steel Framing | <input type="checkbox"/> Special Cases                         |

Special Inspection Agencies	Firm	Address, Telephone, e-mail
1. <b>Special Inspection Coordinator</b>	TBD	
2. Inspector		
3. Inspector		
4. Testing Agency	TBD	
5. Testing Agency		
6. Other		

Note: The inspectors and testing agencies shall be engaged by the Owner or the Owner's Agent, and not by the Contractor or Subcontractor whose work is to be inspected or tested. Any conflict of interest must be disclosed to the Building Official, prior to commencing work.

## Soils and Foundations

Item	Agency # (Qualif.)	Scope
1. Shallow Foundations	1/4	<i>Observe that bearing materials at bottom of footings and slabs are consistent with material encountered in the design phase explorations and are suitable to support the new structure. Refer to the Geotechnical Study for the site for additional information.</i>
2. Controlled Structural Fill	4	<i>Perform sieve tests (ASTM D422 &amp; D1140) and modified Proctor tests (ASTM D1557) of each source of fill material. Observe placement, lift thickness and compaction of controlled fill. Test density of each lift of fill by nuclear methods (ASTM D2922) Verify extent and slope of fill placement.</i>
3. Deep Foundations		
4. Load Testing		
4. Other:		

## Cast-in-Place Concrete

Item	Agency # (Qualif.)	Scope
1. Mix Design	4	<i>Review concrete batch tickets and verify compliance with approved mix design. Verify that water added at the site does not exceed that allowed by the mix design.</i>
2. Material Certification	1 4	<i>Review certificates of conformance. Verify use of specified material in field.</i>
3. Reinforcement Installation	1/4	<i>Observe size, spacing, cover, positioning and grade of reinforcing steel. Verify that reinforcing bars are free of form oil or other deleterious materials. Observe bar laps and mechanical splices. Verify that bars are adequately tied and supported on chairs or bolsters. Observe a minimum of 50%.</i>
4. Post-Tensioning Operations		
5. Welding of Reinforcing		
6. Anchor Rods	4	<i>Observe size, positioning and embedment of anchor rods. Inspect concrete placement and consolidation around anchors.</i>
7. Concrete Placement	4	<i>Observe placement of concrete. Verify that concrete conveyance and depositing avoids segregation or contamination. Verify that concrete is properly consolidated.</i>
8. Sampling and Testing of Concrete	4	<i>Test concrete compressive strength (ASTM C31 &amp; C39), slump (ASTM C143), air-content (ASTM C231 or C173) and temperature (ASTM C1064).</i>
9. Curing and Protection	1/4	<i>Observe curing, cold weather protection and hot weather protection procedures when present for inspection and/or testing.</i>
10. Other:		

**Masonry**Required Inspection Level:  1  2

Item	Agency # (Qualif.)	Scope
1. Material Certification		
2. Mixing of Mortar and Grout	4	<i>Observe proportioning, mixing and retempering of mortar and grout.</i>
3. Installation of Masonry	4	<i>Observe size, layout, bonding and placement of masonry units.</i>
4. Mortar Joints	4	<i>Observe construction of mortar joints including tooling and filling of head joints.</i>
5. Reinforcement Installation	4	<i>Observe placement, positioning and lapping of reinforcing steel.</i>
6. Prestressed Masonry		
7. Grouting Operations	4	<i>Observe placement and consolidation of grout. Inspect masonry clean-outs for high-lift grouting.</i>
7. Weather Protection	4	<i>Observe cold weather protection and hot weather protection procedures. Verify that wall cavities are protected against precipitation.</i>
9. Evaluation of Masonry Strength	4	<i>Test compressive strength of mortar and grout cube samples (ASTM C780). Test compressive strength of masonry prisms (ASTM C1314).</i>
10. Anchors and Ties	4	<i>Inspect size, location, spacing and embedment of dowels, anchors and ties.</i>
11. Other:		

## Structural Steel

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures <input type="checkbox"/> Fabricator Exempt	4	<i>Review shop fabrication and quality control procedures.</i>
2. Material Certification	4	<i>Review certified mill test reports and identification markings on wide-flange shapes, high-strength bolts, nuts and welding electrodes</i>
3. Open Web Steel Joists	4	<i>Observe installation, field welding and bridging of joists.</i>
4. Bolting	4	<i>Observe installation and tightening of high-strength bolts. Verify that splines have separated from tension control bolts. Verify proper tightening sequence. Continuous inspection of bolts in slip-critical connections.</i>
5. Welding	4	<i>Visually inspect all welds. Inspect pre-heat, post-heat and surface preparation between passes. Verify size and length of fillet welds.  Ultrasonic testing of all full-penetration welds.</i>
6. Shear Connectors	4	<i>Observe size, number, positioning and welding of shear connectors. Inspect studs for full 360 degree flash. Ring test all shear connectors with a 3 lb hammer. Bend test all questionable studs to 15 degrees.</i>
7. Structural Details	1/4	<i>Observe steel frame for compliance with structural drawings, including bracing, member configuration and connection details.</i>
8. Metal Deck	4	<i>Observe welding and side-lap fastening of metal roof and floor deck.</i>
9. Other:		

## Cold-Formed Steel Framing

Item	Agency # (Qualif.)	Scope
1. Member Sizes	<i>1/4</i>	<i>Verify member sizes are in general conformance with design drawings.</i>
2. Material Thickness		
3. Material Properties		
4. Mechanical Connections	<i>1/4</i>	<i>Verify connections are in general conformance with design drawings and approved shop drawings.</i>
5. Welding		
6. Framing Details	<i>1/4</i>	<i>Verify framing is in general conformance with design drawings.</i>
7. Trusses		
8. Permanent Truss Bracing		
9. Other:		

## Wood Construction

Item	Agency # (Qualif.)	Scope
1. Fabricator Certification/ Quality Control Procedures <input type="checkbox"/> Fabricator Exempt	4	<i>Inspect shop fabrication and quality control procedures for wood glulam members.</i>
2. Material Grading	1/4	<i>Verify material marks are in conformance with the drawings and specs.</i>
3. Connections	1/4	<i>Verify connections for glulams and SIPs are in general conformance with design drawings and manufacturer's approved shop drawings.</i>
4. Framing and Details	1/4	<i>Verify framing is in general conformance with design drawings.</i>
5. Diaphragms and Shearwalls	1/4	<i>Observe size, configuration, blocking and fastening of SIP shearwalls and diaphragms. Verify panel grade and thickness.</i>
6. Prefabricated Wood Trusses	NA	
7. Permanent Truss Bracing	NA	
8. Other:		



# Final Report of Special Inspections

---

Project: *DEEP Western District Headquarters*  
Location: *2065 Thomaston Rd, Watertown, CT 06795*  
Owner: *CT DEEP*  
Owner's Address: *79 Elm St, Hartford, CT 06106*

Architect of Record: *TLB Architecture, LLC*  
Structural Engineer of Record: *GNCB Consulting Engineers, P.C.*

To the best of my information, knowledge and belief, the Special Inspections required for this project, and itemized in the *Statement of Special Inspections* submitted for permit, have been performed and all discovered discrepancies have been reported and resolved other than the following:

Comments:

*(Attach continuation sheets if required to complete the description of corrections.)*

Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully submitted,  
Special Inspector

\_\_\_\_\_  
(Type or print name)

\_\_\_\_\_  
Signature

\_\_\_\_\_  
Date



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**Section 50 80 00  
Additional Information**

**Subsection 50 80 00.1  
Geothermal Well Conductivity  
Testing Report**





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**FORMATION THERMAL CONDUCTIVITY  
TEST & DATA ANALYSIS**

---

**TEST LOCATION**    **Black Rock State Park  
Watertown, CT**

**TEST DATE**    June 11-13, 2019

**ANALYSIS FOR**    Connecticut Wells Inc.  
49 Hard Hill Road North  
Bethlehem, CT 06751  
Phone: (203) 266-5272

**TEST PERFORMED BY**    Connecticut Wells Inc.

## EXECUTIVE SUMMARY

---

A formation thermal conductivity test was performed at Black Rock State Park at 2065 Thomaston Road in Watertown, Connecticut. The vertical bore was completed on June 3, 2019 by Connecticut Wells Inc. Geothermal Resource Technologies' (GRTI) test unit was attached to the vertical bore on the morning of June 11, 2019.

This report provides an overview of the test procedures and analysis process, along with plots of the loop temperature and input heat rate data. The collected data was analyzed using the "line source" method and the following average formation thermal conductivity was determined.

**Formation Thermal Conductivity = 1.82 Btu/hr-ft-°F**

Due to the necessity of a thermal diffusivity value in the design calculation process, an estimate of the average thermal diffusivity was made for the encountered formation.

**Formation Thermal Diffusivity  $\approx$  1.21 ft<sup>2</sup>/day**

The undisturbed formation temperature for the tested bore was established from the initial loop temperature data collected at startup.

**Undisturbed Formation Temperature  $\approx$  53.1-54.0°F**

The formation thermal properties determined by this test do not directly translate into a loop length requirement (i.e. feet of bore per ton). These parameters, along with many others, are inputs to commercially available loop-field design software to determine the required loop length. Additional questions concerning the use of these results are discussed in the frequently asked question (FAQ) section at [www.grti.com](http://www.grti.com).

## TEST PROCEDURES

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The American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE) has published recommended procedures for performing formation thermal conductivity tests in the ASHRAE HVAC Applications Handbook, Geothermal Energy Chapter. The International Ground Source Heat Pump Association (IGSHPA) also lists test procedures in their Design and Installation Standards. GRTI's test procedures meet or exceed those recommended by ASHRAE and IGSHPA, with the specific procedures described below:

**Grouting Procedure for Test Loops** – To ensure against bridging and voids, it is recommended that the bore annulus is uniformly grouted from the bottom to the top via tremie pipe.

**Time Between Loop Installation and Testing** – A minimum delay of five days between loop installation and test startup is recommended for bores that are air drilled, and a minimum waiting period of two days for mud rotary drilling.

**Undisturbed Formation Temperature Measurement** – The undisturbed formation temperature should be determined by recording the loop temperature as the water returns from the u-bend at test startup.

**Required Test Duration** – A minimum test duration of 36 hours is recommended, with a preference toward 48 hours.

**Data Acquisition Frequency** - Test data is recorded at five minute intervals.

**Equipment Calibration/Accuracy** – Transducers and datalogger are calibrated per manufacturer recommendations. Manufacturer stated accuracy of power transducers is less than  $\pm 2\%$ . Temperature sensor accuracy is periodically checked via ice water bath.

**Power Quality** – The standard deviation of the power should be less than or equal to 1.5% of the average power, with maximum power variation of less than or equal to 10% of the average power.

**Input Heat Rate** – The heat flux rate should be 51 Btu/hr (15 W) to 85 Btu/hr (25 W) per foot of installed bore depth to best simulate the expected peak loads on the u-bend.

**Insulation** – GRTI's equipment has 1 inch of foam insulation on the FTC unit and 1/2 inch of insulation on the hose kit connection. An additional 2 inches of insulation is provided for both the FTC unit and loop connections by insulating blankets.

**Retesting in the Event of Failure** – In the event that a test fails prematurely, a retest may not be performed until the bore temperature is within 0.5°F of the original undisturbed formation temperature or until a period of 14 days has elapsed.

## DATA ANALYSIS

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Geothermal Resource Technologies, Inc. (GRTI) uses the "line source" method of data analysis to determine the thermal conductivity of the formation. The line source method assumes an infinitely thin line source of heat in a continuous medium. A plot of the late-time temperature rise of the line source temperature versus the natural log of elapsed time will follow a linear trend. The linear slope is inversely proportional to the thermal conductivity of the medium. Applying the line source method to a u-bend grouted in a borehole, the test must be run long enough to allow the finite dimensions of the u-bend pipes and the grout to become insignificant. Experience has shown that approximately ten hours is required to allow the error of early test times and the effects of finite borehole dimensions to become insignificant.

In the analysis of the data from the formation thermal conductivity test, the average temperature of the water entering and exiting the u-bend heat exchanger was plotted versus the natural log of elapsed testing time. Using the Method of Least Squares, linear coefficients were calculated that produce a line that fit the data. This procedure was repeated for various time intervals to ensure that variations in the power or other effects did not produce inaccurate results.

The calculated results are based on test bore information submitted by the driller/testing agency. GRTI is not responsible for inaccuracies in the results due to erroneous bore information. All data analysis is performed by personnel that have an engineering degree from an accredited university with a background in heat transfer and experience with line source theory. The test results apply specifically to the tested bore. Additional bores at the site may have significantly different results depending upon variations in geology and hydrology.

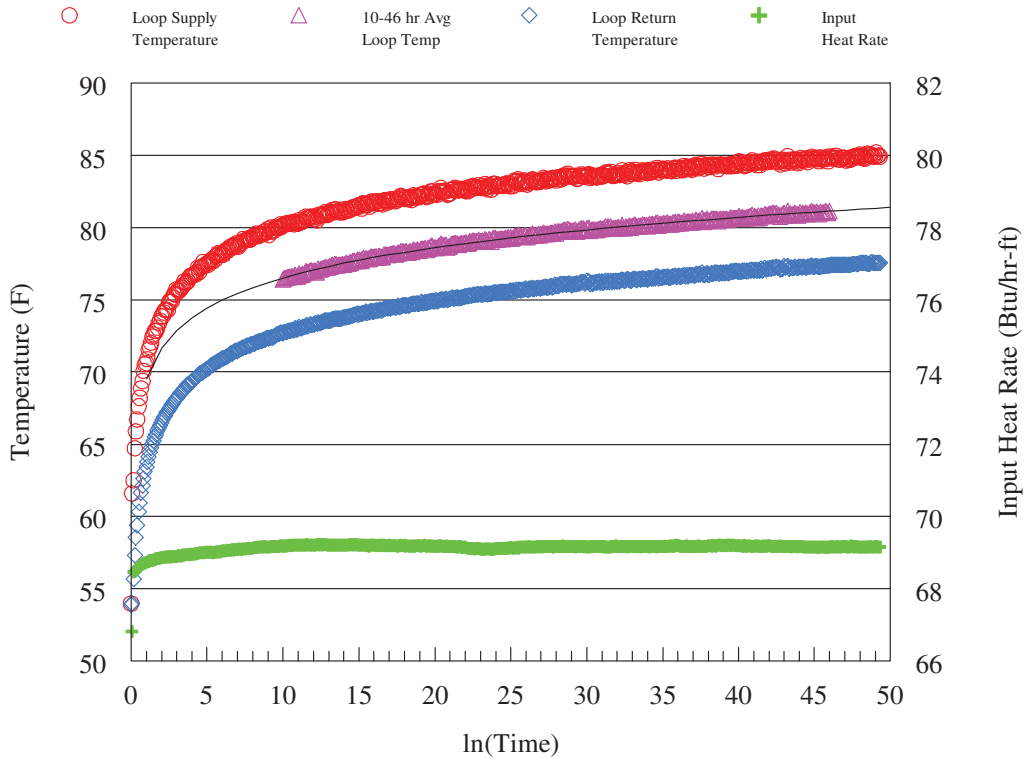
Through the analysis process, the collected raw data is converted to spreadsheet format (Microsoft Excel®) for final analysis. If desired, please contact GRTI and a copy of the data will be made available in either a hard copy or electronic format.

**CONTACT:** Chad Martin  
Regional Managing Engineer  
Asheville, NC  
(828) 225-9166  
[cmartin@grti.com](mailto:cmartin@grti.com)





## THERMAL CONDUCTIVITY TEST DATA



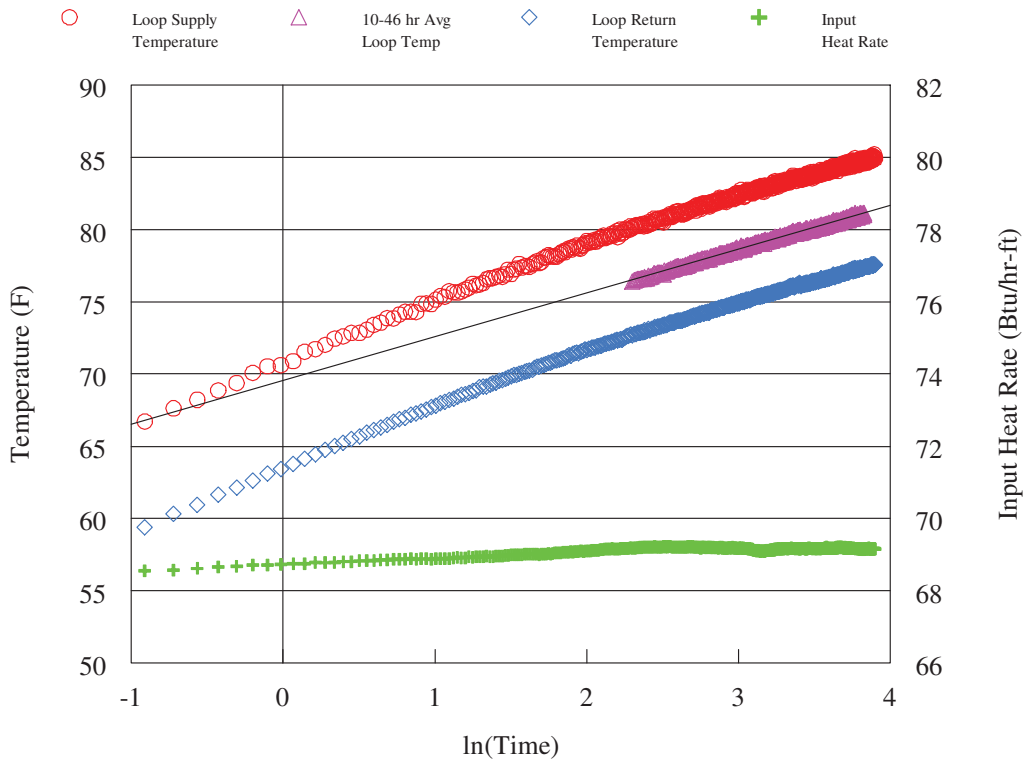
**FIG. 1: TEMPERATURE & HEAT RATE DATA VS TIME**

Figure 1 above shows the loop temperature and heat input rate data versus the elapsed time of the test. The temperature of the fluid supplied to and returning from the U-bend are plotted on the left axis, while the amount of heat supplied to the fluid is plotted on the right axis on a per foot of bore basis. In the test statistics below, calculations on the power data were performed over the analysis time period listed in the Line Source Data Analysis section.

### SUMMARY TEST STATISTICS

Test Date .....	June 11-13, 2019
Undisturbed Formation Temperature .....	Approx. 53.1-54.0°F
Duration .....	49.3 hr
Average Voltage .....	239.6 V
Average Heat Input Rate .....	34,590 Btu/hr (10,135 W)
Avg Heat Input Rate per Foot of Bore .....	69.2 Btu/hr-ft (20.3 W/ft)
Circulator Flow Rate .....	9.3 gpm
Standard Deviation of Power .....	0.04%
Maximum Variation in Power .....	0.13%

## LINE SOURCE DATA ANALYSIS



**FIG. 2: TEMPERATURE & HEAT RATE VS NATURAL LOG OF TIME**

The loop temperature and input heat rate data versus the natural log of elapsed time are shown above in Figure 2. The temperature versus time data was analyzed using the line source method (see page 3) in conformity with ASHRAE and IGSHPA guidelines. A linear curve fit was applied to the average of the supply and return loop temperature data between 10 and 46.0 hours. The slope of the curve fit was found to be 3.02. The resulting thermal conductivity was found to be **1.82 Btu/hr-ft-°F**.

## THERMAL DIFFUSIVITY

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The reported drilling log for this test borehole indicated that the formation consisted of sand, gravel, limestone, schist, and mica. Heat capacity values for limestone and schist were calculated from specific heat and density values listed by Kavanaugh and Rafferty<sup>1</sup>. A weighted average of heat capacity values based on the indicated formation was used to determine an average heat capacity of 36.2 Btu/ft<sup>3</sup>-°F for the formation. A diffusivity value was then found using the calculated formation thermal conductivity and the estimated heat capacity. The thermal diffusivity for this formation was estimated to be **1.21 ft<sup>2</sup>/day**.

<sup>1</sup>Stephen P. Kavanaugh and Kevin Rafferty, Geothermal Heating and Cooling: Design of Ground-Source Heat Pump Systems (Atlanta: ASHRAE, 2014), 75.

## CERTIFICATE OF CALIBRATION

GRTI maintains calibration of the datalogger, current transducer and voltage transducer on a regular schedule. The components are calibrated by the manufacturer using recognized national or international measurement standards such as those maintained by the National Institute of Standards and Technology (NIST).

FTC Unit     214    

DA Unit     65    

PRIMARY EQUIPMENT		
COMPONENT	CALIBRATION DATE	CALIBRATION DUE DATE
Datalogger	9/24/2018	9/24/2021
Current Transducer	9/26/2018	9/26/2021
Voltage Transducer	9/26/2018	9/26/2021

GRTI periodically verifies the combined temperature sensor/datalogger accuracy via a water bath. Temperature readings are simultaneously taken with a digital thermometer that has been calibrated using instruments traceable to NIST.

DATE	10/3/2018	1/10/2018		
THERMOCOUPLE 1 (°F)	32.0 31.9 31.8	80.0 80.0 80.1		
THERMOCOUPLE 2 (°F)	32.0 31.9 31.8	80.0 80.1 80.1		
THERMOCOUPLE 3 (°F)	32.0 31.9 31.9	79.9 80.0 80.0		
THERMOCOUPLE 4 (°F)	32.0 32.0 31.9	79.9 80.0 80.0		
DIGITAL THERMOMETER (°F)	32.1 32.1 32.0	79.8 79.9 79.9		



**Section 50 80 00  
Additional Information**

**Subsection 50 80 00.2**

***CT DEEP License and Flood  
Management Certification Approval***

***General Permit for Resource  
Construction Activities – Approval  
of Authorization***





**Connecticut Department of Energy and Environmental Protection License\***

**Flood Management Certification Approval**

**General Permit for Water Resource Construction Activities - Approval of Authorization**

**Licensee(s):** Connecticut Department of Energy and Environmental Protection

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**Licensee Address(s):** Bureau of Central Services  
79 Elm Street, Hartford, CT

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**License Number(s):** 202007197-FM 202007196-GPCST

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**Municipality:** Thomaston and Watertown

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**Project Description:** Construction of a DEEP Western District Headquarters, maintenance garage, and associated parking and utilities (Watertown) and new utility installation and sanitary sewer pump station for Black Rock State Park (Thomaston)

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**Project Address/Location:** 2065 Thomaston Road, Watertown  
422 Watertown Road, Thomaston

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**Waters:** Branch Brook and Black Rock Pond

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**Authorizing CT Statute(s) and/or Federal Law:** CGS Section 25-68b to h; CGS Section 22a-36 to 45

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**Applicable Regulations of CT State Agencies:** 25-68h-1 to 3, 22a-39-1 to 15

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**Agency Contact:** Land & Water Resources Division,  
Bureau of Water Protection & Land Reuse, 860-424-3019

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**License Expiration:** Five (5) years from the date of issuance of this license for the Flood Management Certification. Upon expiration of the General Permit for Water Resource Construction Activities, April 2, 2024 for inland wetlands and watercourse activities.

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**Project Site Plan Set:** *DEEP West District Headquarters, Black Rock State Park, 2056 Thomaston Road, Watertown, Connecticut, Project No. BI-T-616, 16 plan sheets (title, V101, V102, CG201, CG301, CG302, CG303, CUI05, CUI06, CX502, CX506, L100, L101, L104, L105, and L301), prepared by Richard Couch, P, Martinez Couch & Associates*

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\*Connecticut's Uniform Administrative Procedure Act defines License to include, "the whole or part of any agency permit, certificate, approval, registration, charter or similar form of permission required by law . . ."

**License Enclosures:** LWRD General Conditions, General Permit - Water Resource  
Construction Activities, Compliance Certification Form

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**Authorized Activities:**

The Licensee is hereby authorized to conduct the following work as described in application nos. 202007196 and 202007197 and as depicted on any site plan sheets / sets cited herein:

Permanent impact of 80 sf of wetlands and watercourse due to directionally drilling under the Branch Brook to provide underground utilities to support a DEEP Western District Headquarters facilities at the Black Rock State Park which include:

1. Construction of a new facilities at 2065 Thomaston Road in Watertown which include:
  - a. a 6,996 sf two-story western district headquarters building, a new 3,224 sf maintenance garage and a new 800 sf pavilion structure;
  - b. cuts and fills and grading needed to install two parking areas (an upper and lower parking lot), install underdrain system for parking areas and driveway access;
  - c. all ADA accessible sidewalks and walkways for new buildings;
  - d. new stormwater drainage system including all collection piping, catch basins, manholes, swales, filtration, and a concrete modular retention unit with an outlet control weir and a 15-inch HDPE piped outlet with riprap outlet protection;
  - e. and final site grading and landscaping.
2. Provide slope stabilization consisting of erosion control blankets, hydro seeding, and a stone swale at the base with a perforated pipe to drain to existing yard drains at northeastern side of site;
3. Install new underground utilities including water, gravity sewers, sanitary sewer force main, and other electrical and communication utilities to support new building facilities.
4. Provide underground utilities connections for water and sewer from (Route 6) Watertown Road in Thomaston via 1,240 linear feet of directional drilling from Watertown Road in Thomaston under the Branch Brook to the Thomaston Road, Watertown site location.

***Failure to comply with the terms and conditions of this license shall subject the Licensee and / or the Licensee's contractor(s) to enforcement actions and penalties as provided by law.***

**This license is subject to the following Terms and Conditions:**

1. **License Enclosure(s) and Conditions.** The Licensee shall comply with all applicable terms and conditions as may be stipulated within the License Enclosure(s) listed above.
2. **Storage within the Floodplain.** The proposed 100-foot by 200-foot staging area for the directional drilling operations shall not be within the 100-year floodplain of Broad Brook.
3. **Drilling Monitoring and Operations.** The Licensee shall implement and establish protocols to be taken in the event of an inadvertent return or a bentonite release or a drilling fluid release into the Branch Brook watershed during directional drilling operations. Such protocols shall be included within the contract specifications and provided to the Commissioner for review and approval prior to commencement of drilling operations. In the event of a bentonite or drilling fluid release to the Branch Brook, a bentonite or fluid containment system shall be installed and maintained in optimal

operating condition throughout the duration of the work authorized herein and shall not be removed until after construction has been completed per authorized activity 4 referenced above, the site has been stabilized, all remediation efforts have been completed and removal of the containment system has been approved in writing by the Commissioner. Any release shall immediately be reported to the Commissioner.

4. **Erosion and Sedimentation Controls.** It is recommended to use 100% biodegradable plant-based products and materials such as jute (vegetable fiber), sisal (stiff agave fiber) or coir (coconut husk fiber) for sedimentation and erosion control within the wetlands and watercourses to be protective of wildlife species such as amphibians, reptiles and birds in the project area. All erosion controls used for the project shall be removed as soon as soils have been stabilized to avoid impending amphibian and reptile movement between wetlands / watercourses and uplands.
5. **Wetland Protections.** Mulches (chemical or organic) cannot be applied within wetlands or immediately adjacent to wetlands and watercourses to mitigate water quality impacts.
6. **Protections for Hairy-Fruited Sedge (*Carex trichocarpa*).** If any wetland or stream disturbances are required to install the sanitary line connection, then a botanical site survey shall be conducted to assess whether there will be any adverse impacts to this plant species. The licensee shall coordinate, prior to commencing any work, with DEEP NDDDB on identifications and any further required protective measures or mitigation.
7. **Protections for Northern Spring Salamander (*Gyrinophilus porphyriticus*).** To protect the State Threatened Northern Spring Salamander the following best management practices measures and procedures listed below shall be implemented and adhered to at the site for the duration of the project.
  - a. A qualified herpetologist/biologist shall be hired to do an assessment of the area and provide a protection and/or conservation plan for the State Threatened species.
  - b. Maintain a qualified herpetologist on site to oversee the implementation of Salamander protection measures and procedures for the duration of the project construction.
  - c. Trees should not be removed adjacent to streams or brook.
  - d. A buffer of at least 100 feet along the watercourse should be maintained to minimize any temperature or microclimate change to the riparian areas.
  - e. Follow any guidelines provided by the qualified herpetologist to prevent killing salamanders while operating and moving heavy equipment.
8. **Protection of Wood Turtles (*Glyptemys insculpta*).** To protect the State Listed Species of Concern; the Wood Turtle, the following measures and procedures listed below are recommended and shall be implemented and adhered to for the duration of construction and including the directional drilling operations under Branch Brook.
  - a. A qualified herpetologist/biologist shall be hired to oversee the implementation of Wood Turtle protection measures and procedures for the duration of the project construction.
  - b. Prior to the start of construction, exclusion fencing shall be installed around the limits of the work area to prevent turtle access to the work area. The exclusion fencing shall be at least 20 inches tall and must be secured to and remain in contact with the ground. Silt fencing installed for erosion control may serve this like purpose. **As used in this condition, “the work area” includes all areas used for site access, equipment parking, material staging, material storage, and construction purposes.**

- c. The exclusion fencing shall be inspected each day prior to the start of work activities. Any gap or breach in the exclusionary fencing shall be fixed or repaired immediately.
  - d. All construction personnel and work crews shall be apprised of the species descriptions and possible presence.
  - e. A search for turtles within the work area shall be completed each work day prior to the start of any work activities. The search shall be performed by the qualified herpetologist/biologist during the month of June. Outside of the month of June, the search may be conducted by a designated employee(s) of the contractor, provided that the designated employee(s) has been appropriately trained by the qualified herpetologist/biologist to perform this function.
  - f. Any turtles that are encountered within the limits of the work area shall be carefully moved, unharmed, to an area immediately outside of the fenced work area and shall be released oriented to head in the same direction as it was found. These animals are protected by law and should not be relocated off-site.
  - g. Any confirmed encounters with Eastern Box Turtle, Wood Turtle, or Spotted Turtle shall be reported and documented with the NDDDB at [nddbrequestdep@ct.gov](mailto:nddbrequestdep@ct.gov) using the special animal form found at [http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323460&depNav\\_GID=1641](http://www.ct.gov/deep/cwp/view.asp?a=2702&q=323460&depNav_GID=1641). Such reports and documentation shall be filed with the NDDDB within 72 hours.
  - h. All exclusion fencing shall be removed immediately after completion of the project. All soil erosion control fencing shall be removed as soon as soil stabilization is completed.
9. **Protections for the Smooth Green Snake (*Opheodrys vernalis*).** To protect the State Listed Species of Concern; the Smooth Green Snake, the following protections and best management practices shall be implemented and adhered to for the duration of the construction work at the site.
- a. Workers shall be apprised of the species description and possible presence. This species favors meadows and grassy fields, often along forested edges.
  - b. The area shall be searched each day prior to commencing construction activities.
  - c. Any snakes encountered during the work shall be moved out of the way, just outside the work area. This species is protected by law and shall not be relocated off-site.
  - d. Vehicles and heavy machinery shall operate at slower speeds to allow animals the time to move from harm's way on their own. Extra care shall be taken in the early morning and evening hours.
  - e. No heavy machinery or vehicles shall be parked in any snake habitat (grassy fields).

Issued under the authority of the Commissioner of Energy and Environmental Protection on:

December 23, 2020  
Date



\_\_\_\_\_  
Brian P. Thompson  
Division Director  
Land & Water Resources Division

## **LWRD General Conditions**

- 1. Land Record Filing (for Structures Dredging & Fill, Tidal Wetlands, Certificate of Permission, and Long Island Sound General Permit Licenses only).** The Licensee shall file the Land Record Filing on the land records of the municipality in which the subject property is located not later than thirty (30) days after license issuance pursuant to Connecticut General Statutes (CGS) Section 22a-363g. A copy of the Notice with a stamp or other such proof of filing with the municipality shall be submitted to the Commissioner no later than sixty (60) days after license issuance. If a Land Record Filing form is not enclosed and the work site is not associated with an upland property, no filing is required.
- 2. Contractor Notification.** The Licensee shall give a copy of the license and its attachments to the contractor(s) who will be carrying out the authorized activities prior to the start of construction and shall receive a written receipt for such copy, signed and dated by such contractor(s). The Licensee's contractor(s) shall conduct all operations at the site in full compliance with the license and, to the extent provided by law, may be held liable for any violation of the terms and conditions of the license. At the work site, the contractor(s) shall, whenever work is being performed, have on site and make available for inspection a copy of the license and the authorized plans.
- 3. Work Commencement<sup>1</sup>.** Not later than two (2) weeks prior to the commencement of any work authorized herein, the Licensee shall submit to the Commissioner, on the Work Commencement Form attached hereto, the name(s) and address(es) of all contractor(s) employed to conduct such work and the expected date for commencement and completion of such work, if any.
  - For water diversion activities authorized pursuant to 22a-377(c)-1 of the Regulations of Connecticut State Agencies, the Licensee shall also notify the Commissioner in writing two weeks prior to initiating the authorized diversion.
  - For emergency activities authorized pursuant Connecticut General Statutes Section 22a-6k, the Licensee shall notify the Commissioner, in writing, of activity commencement at least one (1) day prior to construction and of activity completion no later than five (5) days after conclusion.
- 4. For Coastal Licenses Only - License Notice.** The Licensee shall post the first page of the License in a conspicuous place at the work area while the work authorized therein is undertaken.
- 5. Unauthorized Activities.** Except as specifically authorized, no equipment or material, including but not limited to, fill, construction materials, excavated material or debris, shall be

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<sup>1</sup> The Work Commencement condition and the need for a Work Commencement Form is not applicable to Flood Management Certification approvals.



deposited, placed or stored in any wetland or watercourse on or off-site. The Licensee may not conduct work within wetlands or watercourses other than as specifically authorized, unless otherwise authorized in writing by the Commissioner. Tidal wetlands means “wetland” as defined by section 22a-29 and “freshwater wetlands and watercourses” means “wetlands” and “watercourses” as defined by section 22a-38.

6. **Unconfined Instream Work.** Unless otherwise noted in a condition of the license, the following conditions apply to projects in non-coastal waters:
  - Unconfined instream work is limited to the period June 1 through September 30.
  - Confinement of a work area by cofferdam techniques using sand bag placement, sheet pile installation (vibratory method only), portadam, or similar confinement devices is allowed any time of the year. The removal of such confinement devices is allowed any time of the year.
  - Once a work area has been confined, in-water work within the confined area is allowed any time of the year.
  - The confinement technique used shall completely isolate and protect the confined area from all flowing water. The use of silt boom/curtain or similar technique as a means for confinement is prohibited.
7. **For State Actions Only - Material or Equipment Storage in the Floodplain.** Unless approved by a Flood Management Exemption, the storage of any materials at the site which are buoyant, hazardous, flammable, explosive, soluble, expansive, radioactive, or which could in the event of a flood be injurious to human, animal or plant life, below the elevation of the five-hundred (500) year flood is prohibited. Any other material or equipment stored at the site below said elevation by the Licensee or the Licensee's contractor must be firmly anchored, restrained or enclosed to prevent flotation. The quantity of fuel stored below such elevation for equipment used at the site shall not exceed the quantity of fuel that is expected to be used by such equipment in one day. In accordance with the licensee's Flood Contingency Plan, the Licensee shall remove equipment and materials from the floodplain during periods when flood warnings have been issued or are anticipated by a responsible federal, state or local agency. It shall be the Licensee's responsibility to obtain such warnings when flooding is anticipated.
8. **Temporary Hydraulic Facilities for Water Handling.** If not reviewed and approved as a part of the license application, temporary hydraulic facilities shall be designed by a qualified professional and in accordance with the *Connecticut Guidelines for Soil Erosion and Sediment Control*, the *2004 Connecticut Stormwater Quality Manual*, or the *Department of Transportation's ConnDOT Drainage Manual*, as applicable. Temporary hydraulic facilities may include channels, culverts or bridges which are required for haul roads, channel relocations, culvert installations, bridge construction, temporary roads, or detours.
9. **Excavated Materials.** Unless otherwise authorized, all excavated material shall be staged and managed in a manner which prevents additional impacts to wetlands and watercourses.
10. **Best Management Practices.** The Licensee shall not cause or allow pollution of any wetlands or watercourses, including pollution resulting from sedimentation and erosion. In constructing

or maintaining any authorized structure or facility or conducting any authorized activity, or in removing any such structure or facility, the Licensee shall employ best management practices to control storm water discharges, to prevent erosion and sedimentation, and to otherwise prevent pollution of wetlands and other waters of the State. For purposes of the license, “pollution” means “pollution” as that term is defined by CGS section 22a-423. Best Management Practices include, but are not limited, to practices identified in the *Connecticut Guidelines for Soil Erosion and Sediment Control* as revised, *2004 Connecticut Stormwater Quality Manual*, Department of Transportation’s *ConnDOT Drainage Manual* as revised, and the Department of Transportation Standard Specifications as revised.

**11. Work Site Restoration.** Upon completion of any authorized work, the Licensee shall restore all areas impacted by construction, or used as a staging area or accessway in connection with such work, to their condition prior to the commencement of such work.

**12. Inspection.** The Licensee shall allow any representative of the Commissioner to inspect the project location at reasonable times to ensure that work is being or has been conducted in accordance with the terms and conditions of this license.

**13. Change of Use. (Applies only if a use is specified within the License “Project Description”)**

- a. The work specified in the license is authorized solely for the purpose set forth in the license. No change in purpose or use of the authorized work or facilities as set forth in the license may occur without the prior written approval of the Commissioner. The Licensee shall, prior to undertaking or allowing any change in use or purpose from that which is authorized by this license, request permission from the Commissioner for such change. Said request shall be in writing and shall describe the proposed change and the reason for the change.
- b. A change in the form of ownership of any structure authorized herein from a rental/lease commercial marina to a wholly-owned common interest community or dockominium may constitute a change in purpose as specified in paragraph (a) above.

**14. De Minimis Alteration.** The Licensee shall not deviate from the authorized activity without prior written approval from the Commissioner. The Licensee may request a de minimis change to any authorized structure, facility, or activity. A de minimis alteration means a change in the authorized design, construction or operation that individually and cumulatively has minimal additional environmental impact and does not substantively alter the project as authorized.

- For diversion activities authorized pursuant to 22a-377(c)-2 of the Regulations of Connecticut State Agencies, a de minimis alteration means an alteration which does not significantly increase the quantity of water diverted or significantly change the capacity to divert water.

**15. Extension Request.** The Licensee may request an extension of the license expiration date. Such request shall be in writing and shall be submitted to the Commissioner at least thirty (30) days prior to the license expiration. Such request shall describe the work done to date, what work still needs to be completed, and the reason for such extension. It shall be the Commissioner’s sole discretion to grant or deny such request.

- 16. Compliance Certification.** Not later than 90 days after completion of the authorized work, the Licensee shall prepare and submit to the Commissioner the attached Compliance Certification Form. Such Compliance Certification shall be completed, signed, and sealed by the Licensee and a Connecticut Licensed Design Professional. If non-compliance is indicated on the form, or the Commissioner has reason to believe the activities and/or structures were conducted in non-compliance with the license, the Commissioner may require the Licensee to submit as-built plans as a condition of this license.
- 17. Maintenance.** The Licensee shall maintain all authorized structures or work in optimal condition or shall remove such structures or facility and restore the affected waters to their pre-work condition. Any such maintenance or removal activity shall be conducted in accordance with applicable law and any additional approvals required by law.
- 18. No Work After License Expiration.** Work conducted after the license expiration date is a violation of the license and may subject the licensee to enforcement action, including penalties, as provided by law.
- 19. License Transfer.** The license is not transferable without prior written authorization of the Commissioner. A request to transfer a license shall be submitted in writing and shall describe the proposed transfer and the reason for such transfer. The Licensee's obligations under the license shall not be affected by the passage of title to the license site to any other person or municipality until such time as a transfer is approved by the Commissioner.
- 20. Document Submission.** Any document required to be submitted to the Commissioner under the license or any contact required to be made with the Commissioner shall, unless otherwise specified in writing by the Commissioner, be directed to:
- Regulatory Section  
Land & Water Resources Division  
Department of Energy and Environmental Protection  
79 Elm Street  
Hartford, Connecticut 06106-5127  
860-424-3019
- 21. Date of Document Submission.** The date of submission to the Commissioner of any document required by the license shall be the date such document is received by the Commissioner. The date of any notice by the Commissioner under the license, including but not limited to notice of approval or disapproval of any document or other action, shall be the date such notice is personally delivered or the date three (3) days after it is mailed by the Commissioner, whichever is earlier. Except as otherwise specified in the license, the word "day" as used in the license means calendar day. Any document or action which is required by the license to be submitted or performed by a date which falls on a Saturday, Sunday or a Connecticut or federal holiday shall be submitted or performed on or before the next day which is not a Saturday, Sunday, or a Connecticut or federal holiday.
- 22. Certification of Documents.** Any document, including but not limited to any notice, which is required to be submitted to the Commissioner under the license shall be signed by the Licensee and by the individual or individuals responsible for actually preparing such



document, each of whom shall certify in writing as follows: “I have personally examined and am familiar with the information submitted in this document and all attachments and certify that based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief, and I understand that any false statement made in this document or its attachments may be punishable as a criminal offense.”

**23. Accuracy of Documentation.** In evaluating the application for the license, the Commissioner has relied on information and data provided by the Licensee and on the Licensee’s representations concerning site conditions, design specifications and the proposed work, including but not limited to representations concerning the commercial, public or private nature of the work or structures, the water-dependency of said work or structures, its availability for access by the general public, and the ownership of regulated structures or filled areas. If such information proves to be false, deceptive, incomplete or inaccurate, the license may be modified, suspended or revoked, and any unauthorized activities may be subject to enforcement action.

**24. Limits of Liability.** In granting the license, the Commissioner has relied on all representations of the Licensee, including information and data provided in support of the Licensee’s application. Neither the Licensee’s representations nor the issuance of the license shall constitute an assurance by the Commissioner as to the structural integrity, the engineering feasibility or the efficacy of such design.

**25. Reporting of Violations.** In the event that the Licensee becomes aware that they did not or may not comply, or did not or may not comply on time, with any provision of this license or of any document incorporated into the license, the Licensee shall immediately notify the agency contact specified within the license and shall take all reasonable steps to ensure that any noncompliance or delay is avoided or, if unavoidable, is minimized to the greatest extent possible. In so notifying the agency contact, the Licensee shall provide, for the agency’s review and written approval, a report including the following information:

- a. the provision(s) of the license that has been violated;
- b. the date and time the violation(s) was first observed and by whom;
- c. the cause of the violation(s), if known;
- d. if the violation(s) has ceased, the duration of the violation(s) and the exact date(s) and times(s) it was corrected;
- e. if the violation(s) has not ceased, the anticipated date when it will be corrected;
- f. steps taken and steps planned to prevent a reoccurrence of the violation(s) and the date(s) such steps were implemented or will be implemented; and
- g. the signatures of the Licensee and of the individual(s) responsible for actually preparing such report.

If the violation occurs outside of normal business hours, the Licensee shall contact the Department of Energy and Environmental Protection Emergency Dispatch at 860-424-3333. The Licensee shall comply with any dates which may be approved in writing by the

Commissioner.

- 26. Revocation/Suspension/Modification.** The license may be revoked, suspended, or modified in accordance with applicable law.
- 27. Other Required Approvals.** License issuance does not relieve the Licensee of their obligations to obtain any other approvals required by applicable federal, state and local law.
- 28. Rights.** The license is subject to and does not derogate any present or future property rights or powers of the State of Connecticut, and conveys no property rights in real estate or material nor any exclusive privileges, and is further subject to any and all public and private rights and to any federal, state or local laws or regulations pertinent to the property or activity affected hereby.
- 29. Condition Conflicts.** In the case where a project specific special condition listed on the license differs from, or conflicts with, one of the general conditions listed herein, the project specific special condition language shall prevail. It is the licensee's responsibility to contact the agency contact person listed on the license for clarification if needed prior to conducting any further regulated activities.

# **General Permit for Water Resource Construction Activities**

**Issuance Date: April 2, 2014**  
**Expiration Date: April 2, 2024**

Bureau of Water Protection and Land Reuse

Inland Water Resources Division

860-424-3019

# General Permit for Water Resource Construction Activities

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## **General Permit for Water Resource Construction Activities**

### **Section 1. Authority**

This general permit is issued under the authority of sections 22a-6, 22a-45a and 22a-378a of the General Statutes. For the purposes of this general permit, authorization under 22a-45a is limited to any proposed regulated activity conducted by any department, agency or instrumentality of the state, except any local or regional board of education.

### **Section 2. Definitions**

As used in this general permit the following definitions shall apply:

*“Authorized activity”* means a regulated activity, including erection, placement, or maintenance of a structure or other facility, conducted or maintained under the authority of section 3 of this general permit.

*“Beach Maintenance Plan”* means a written plan for maintaining beach facilities. Such plan describes the location of any such facilities, describes in detail maintenance activities to be carried out and typical design specifications and plans for such activities, estimates of the quantities of material to be placed or removed in connection with such maintenance activities, describes procedures for disposal of excess material and solid waste generated in connection with such maintenance activities, and the best management practices to be implemented while conducting such maintenance activities, including measures to ensure fish passage and minimize damage to habitat for fish, wildlife, or stream invertebrates.

*“Best management practice”* means a practice, procedure, activity, structure or facility designed to prevent or minimize pollution or other environmental damage or to maintain or enhance existing environmental quality. Best management practices include, but are not limited to: erosion and sedimentation controls; restrictions on land use or development; construction setbacks from wetlands and watercourses; proper disposal of waste materials; procedures for equipment maintenance that prevent fuel spillage; construction methods to prevent flooding or disturbance of wetlands and watercourses; construction methods to maintain continuous stream flow; confining construction that must take place in a watercourse to occur when water flows are low and fish and wildlife will not be adversely affected.

*“Boat Launch Maintenance Plan”* means a written plan for maintaining boat launch facilities. Such plan describes the location of any such facilities, describes in detail maintenance activities to be carried out and typical design specifications and plans for such activities, estimates of the quantities of material to be placed or removed in connection with such maintenance activities, describes procedures for disposal of excess material and solid waste generated in connection with such maintenance activities, and the best management practices to be implemented while conducting such maintenance activities, including measures to ensure fish passage and minimize damage to habitat for fish, wildlife, or stream invertebrates.

“*CFR*” means Code of Federal Regulations.

“*Commissioner*” means the means the commissioner as defined by section 22a-2(b) of the General Statutes.

“*Consumptive use*” means any withdrawal or removal of water from the waters of the State, including but not limited to any withdrawal or removal from public or private water supply for industrial use, irrigation, hydropower generation, flood management, water quality management, recreation,

landscaping ponds and decorative water fountains, or any other purpose or use.

“*Department*” means the Department of Energy and Environmental Protection.

“*Diversion*” means diversion as defined in section 22a-367 of the General Statutes.

“*Divert*” means divert as defined in section 22a-367 of the General Statutes.

“*Drainage Maintenance Plan*” means a written plan for maintaining drainage facilities, and may include without limitation provision for channels, basins, bridges, culverts or pipes. Such plan describes the location of any such facilities, describes in detail maintenance activities to be carried out and typical design specifications and plans for such activities, estimates of the quantities of material to be placed or removed in connection with such maintenance activities, describes procedures for disposal of excess material and solid waste generated in connection with such maintenance activities, and the best management practices to be implemented while conducting such maintenance activities, including measures to ensure fish passage and minimize damage to habitat for fish, wildlife, or stream invertebrates. Where the subject activity involves the construction, erection or maintenance of a structure or other facility, other than a highway or bridge, owned or operated by the State of Connecticut, such plan incorporates the applicable requirements for drainage basin stormwater management plans in section 25-68h-3 of the Regulations of Connecticut State Agencies.

“*Excess material*” means material such as soil, sand, gravel, stone, or debris, produced by the construction of an authorized activity which material is not utilized in such construction.

“*FEMA*” means the Federal Emergency Management Agency.

“*Floodplain*” means floodplain as defined in section 25-68b of the General Statutes.

“*Floodway*” means the regulatory floodway as defined in 44 CFR Chapter 1, Part 59.1 for a particular watercourse and delineated on a map titled *Floodway & Flood Boundary Map* or *Flood Insurance Rate Map* issued by the FEMA for the municipality wherein such watercourse is located.

“*Groundwater*” means that portion of waters, as the term waters is defined in section 22a-367 of the General Statutes, located at or below the ground surface.

“*Hydrologic and hydraulic design report*” means a report consisting of engineering studies, design computations and other documentation as appropriate to fully and clearly describe the design of the proposed activity and the hydrologic and hydraulic effects thereof.

“*Individual permit*” means a permit issued by the commissioner to a named permittee pursuant to section 22a-39, 22a-342 or 22a-368 of the General Statutes.

“*Material*” means material as defined in section 22a-38 of the General Statutes.

“*Non-consumptive use*” means any diversion of waters of the State due to channelizing, damming, collecting, piping, culverting, filling, relocating or dredging such waters or the detaining of stormwater for the purpose of stormwater management.

“*Permittee*” means any person or municipality whose request for authorization has been approved by the commissioner.

“*Person*” means person as defined in section 22a-2 of the General Statutes.

“*Pollution*” means pollution as defined in section 22a-423 of the General Statutes.

“*Power loading*” means the use of a boat's motor to assist in loading such boat onto a trailer.

“*Regulated activity*” means any activity regulated by the commissioner under sections 22a-39 or 22a-368 of the General Statutes.

“*Requester*” means the person who submits to the commissioner a request for authorization.

“*Request for authorization*” means a request for authorization submitted under Section 4 of this general permit.

“*Solid waste*” means solid waste as defined in section 22a-207 of the General Statutes.

“*Structure*” means any man-made object erected or placed above, on, or in the ground or under water.

“*Surface water*” means that portion of waters as defined in section 22a-367 of the General Statutes located above the ground surface.

“*Trail Maintenance Plan*” means a written plan for maintaining recreational trails. Such plan describes the location of any such facilities, describes in detail

maintenance activities to be carried out and typical design specifications and plans for such activities, estimates of the quantities of material to be placed or removed in connection with such maintenance activities, describes procedures for disposal of excess material and solid waste generated in connection with such maintenance activities, and the best management practices to be implemented while conducting such maintenance activities, including measures to ensure fish passage and minimize damage to habitat for fish, wildlife, or stream invertebrates.

“*Watercourses*” means watercourses as defined in section 22a-38 of the General Statutes.

“*Waters*” means waters as defined in section 22a-367 of the General Statutes.

“*Wetlands*” means wetlands as defined in section 22a-38 of the General Statutes.

### **Section 3. Authorization Under This General Permit**

#### **(a) Eligible Activities**

##### **(1) Drainage Maintenance**

Excavation of accumulated sediment or removal of brush or debris from an area not greater than fifty (50) feet in length from the inlet and outlet sides of a drainage pipe, culvert or bridge; cleaning or reshaping a man-made drainage way or sediment basin; installation or repair of the end wall of a culvert or bridge; repair of erosion damage; repair of a drainage pipe, culvert or bridge; and replacement of a culvert or bridge which receives drainage from a watershed of one (1) square mile or less provided: 1) any such activities are performed pursuant to a drainage maintenance plan approved, in writing, by the commissioner under Section 4 of this general permit and 2) any such activity does not involve placement of more than fifty (50) cubic yards of fill in wetlands, watercourses or floodplains.

##### **(2) Trail Maintenance**

Repair or replacement of existing nature access structures; repair or replacement of footings, foundations, piers, structural piles, posts or supports for a boardwalk; grading and placement of fill for the installation of landscape timbers and / or stone walls; placement or removal of fill for the maintenance of an existing path or trail provided any such activities are performed pursuant to a trail maintenance plan approved in writing by the commissioner under Section 4 of this general permit.

##### **(3) Boat Launch Maintenance**

Repair or in-kind replacement of existing boat launch ramps; removal of accumulated sediment; filling of in-water scour holes caused by power loading or other disturbance; repair or in-kind replacement to docks, pilings, and associated structures provided any such activities are



performed pursuant to a boat maintenance plan approved, in writing, by the commissioner under Section 4 of this general permit.

- (4) Beach Maintenance for Inland Beaches  
Re-grading existing beaches; and replacement of sand on existing beaches to fill sink holes or eroded areas provided such activities are performed pursuant to a beach maintenance plan approved, in writing, by the commissioner under Section 4 of this general permit. This general permit is not intended to authorize the expansion of any beach area beyond existing limits.
- (5) Infrastructure Repairs  
Repair or replacement of a bridge; placement, repair, or replacement of cables, conduits or pipelines; placement of fill or disturbance to wetlands, watercourses or flood plains for roadway reconstruction provided that such repairs do not impact more than 0.10 acres of wetlands, watercourses or floodplains.
- (6) Public Works Projects  
Building additions, parking lot expansions or general facility upgrades (including but not limited to sidewalks, drainage improvements to existing stormwater drainage systems or embankment repairs) that do not impact more than 0.10 acres of wetlands, watercourses or floodplains.
- (7) Trail Construction  
Construction of a new boardwalk or trail; Expansion or extension of an existing boardwalk or trail; nature access structure; footings, foundations, piers, structural piles, posts or supports for a boardwalk or trail; grading and placement of fill for the installation of landscape timbers and / or stone walls associated with a trail provided any such activity does not involve placement of more than fifty (50) cubic yards of fill or impact more than 0.10 acres of wetlands, watercourses or floodplains.
- (8) Activities Authorized Under a Department of Army (US Army Corps of Engineers) General Permit, and Activities Authorized Under a General Section 401 Water Quality Certification Issue by the Department.  
  
Any activity for which an authorization has been granted under a Department of Army (US Army Corps of Engineers) General Permit provided 1) the commissioner has granted a section 401 water quality certification for such Department of the Army General Permit, 2) the activity is consistent with the section 401 water quality certification granted by the commissioner for such Department of the Army General Permit, and 3) the conditions of Section 3(b) of this general permit have been satisfied. *The issuance of a provisional permit or authorization by the Army Corps of Engineers for an activity does not satisfy the*

*requirements for authorization under this general permit.*

Any activity for which a General Section 401 Water Quality Certification has been granted by the commissioner provided the activity is consistent with such section 401 water quality certification and the conditions of Section 3(b) of this general permit have been satisfied.

- (9) Conservation Activities  
Practices or activities for the purposes of conservation of soil, vegetation, water, fish, shellfish and wildlife, including installation and maintenance of aquatic and fish habitat improvement structures.

**(b) Requirements for Authorization**

This general permit authorizes a regulated activity listed in Section 3(a) of this general permit, provided:

- (1) For those activities identified under Section 3(a) (8) and (9) of this general permit, a completed Request for Authorization form and designated fee have been filed with the commissioner.
- (2) For those activities identified under Section 3(a) (1), (2), (3), (4), (5), (6) and (7) of this general permit, a completed Request for Authorization Form and designated fee has been filed with the commissioner **and** the commissioner subsequently issues a written approval.
- (3) Flood Management Certification by State Agency  
If such activity is maintained or proposed by a Connecticut state agency, such agency has complied with and obtained approval from the commissioner from sections 25-68b through 25-68h, inclusive, of the General Statutes, and sections 25-68h-1 through 25-68h-3 of the Regulations of Connecticut State Agencies, inclusive.
- (4) Floodplain Management  
Such activity does not and will not cause or contribute to flooding or flood hazards, permanently obstruct a floodway, or interfere with federal, state or local flood management efforts, and does and will comply with 44 CFR Chapter 1, Parts 59 through 79, inclusive.
- (5) Coastal Permits  
If such activity is located, wholly or in part, waterward of the coastal jurisdiction line in tidal, coastal or navigable waters of the State or in tidal wetlands, the activity has been authorized pursuant to sections 22a-359 through 22a-363f, inclusive, or 22a-28 through 22a-35, inclusive, or 22a-92, of the General Statutes.

- (6) **Endangered and Threatened Species**  
Such activity does not threaten the continued existence of any species listed pursuant to section 26-306 of the General Statutes and will not result in the destruction or adverse modification of habitat designated as essential to such species.
  - (7) **Aquifer Protection**  
Such activity, if it is located within an aquifer protection area as mapped under section 22a-354b of the General Statutes, complies with regulations adopted pursuant to section 22a-354i of the General Statutes.
  - (8) **Conservation and Preservation Restrictions**  
If such activities are located on or may affect property subject to a conservation or preservation restriction, pursuant to section 47-42d of the Connecticut General Statutes, proof of written notice to the holder of such restriction of the proposed activity's registration pursuant to this general permit or a letter from the holder of such restriction verifying that the proposed activity is in compliance with the terms of the restriction shall have been provided to the commissioner.
- (c) ***Geographic Area***  
This general permit shall apply throughout the State of Connecticut.
- (d) ***Effective Date and Expiration Date of This General Permit***  
This general permit shall be effective on the date it is issued and shall expire on the date ten (10) years thereafter.
- (e) ***Effective Date of Authorization***
- (1) For those activities eligible for authorization under Section 3(a) (8) and (9) of this general permit, where written approval from the commissioner is **not** required, the effective date of authorization of such activity shall be the date the commissioner receives the filing fee and a completed request for authorization for such activity.
  - (2) For those activities eligible for authorization under Section 3(a) (1), (2), (3), (4), (5), (6) and (7) of this general permit, where an approval from the commissioner is required, the effective date of authorization of such activity shall be the date the commissioner issues a written approval of such request for authorization for such activity.
- (f) ***Transition to and from an Individual Permit***  
No person shall operate or conduct an activity authorized by both an individual permit and this general permit. The requirements for transitioning authorization are as follows:
- (1) ***Transition from an Individual Permit to Authorization under this General Permit.*** If an activity meets the requirements of authorization of this General Permit and such operation or activity is presently authorized

by an individual permit, the entity to whom any such individual permit has been issued (“the Permittee”) may surrender the right to operate or conduct any activity under such individual permit. The Permittee shall acknowledge its intention to surrender its permit in writing on a form prescribed by the commissioner. However, any such surrender shall not take effect, and such Permittee’s individual permit shall continue to apply, until the date that the commissioner issues an authorization for such operation or activity under this General Permit.

(2) *Transition from Authorization under this General Permit to an Individual Permit.* If the commissioner approves a request for authorization under this General Permit and subsequently issues an individual permit for the same activity, then on the date any such individual permit is issued by the commissioner, the authorization issued under this General Permit shall automatically expire.

**(g) *Activities Not Authorized by This General Permit***

A regulated activity may not lawfully be conducted or maintained unless it is authorized under this general permit or authorized by an individual permit.

(1) The diversion of water for consumptive use is not authorized by this general permit.

(2) Any activity for which the commissioner has denied eligibility for federal Clean Water Act section 401 Water Quality Certification under Category 1 or Category 2 of the Connecticut General Permit (US Army Corps of Engineers) is not authorized by this general permit.

#### **Section 4. Request for Authorization**

**(a) *Who Must File a Request for Authorization***

Any person or municipality seeking under the authority of this general permit to undertake a regulated activity, shall file with the commissioner: 1) a request for authorization form which meets the requirements of Section 4 of this general permit; and 2) the applicable fee.

Note: Activities that previously received authorization under the *General Permit for Minor Structures (DEP-IWRD-006)*, *General Permit for Minor Grading (DEP-IWRD-007)*, *General Permit for Placement of Utilities and Drainage (DEP-IWRD-005)*, *General Permit for Habitat Conservation (DEP-IWRD-003)* and *General Permit for Lakes, Ponds and Basin Dredging (DEP-IWRD-004)* shall remain authorized for a period of three years from the date of authorization regardless of the expiration of the general permit itself.

**(b) *Scope of Request for Authorization***

A requester shall file a Request for Authorization Form for each site where an activity or activities are proposed. Where activities are proposed to be conducted at more than one site, a separate Request for Authorization Form shall be filed for each site.

**(c) *Contents of Request for Authorization***

**(1) Fees**

- (A) The filing fee of \$ 5,000 shall be submitted with each approval of request for authorization for activities pursuant to Sections 3(a) (1), (2), (3), (4), (5), (6) and (7) of this general permit except: 1) the approval of request for authorization fee for a municipality for such activities shall be discounted 50% or 2) the request for authorization fee shall be discounted 50% if the filing is done electronically.
- (B) The filing fee of \$ 2,500 shall be submitted with each request for authorization for activities pursuant to Sections 3(a) (8) and (9) of this general permit except: 1) the request for authorization fee for a municipality for such activities shall be discounted 50% or 2) the request for authorization fee shall be discounted 50% if the filing is done electronically.
- (C) In accordance with 22a-6f of the Connecticut General Statutes no fee shall be required from any agency, board, commission, council or department of the state, provided that the agency, board, commission, council or department of the state has compensated the Department in an amount equal to such fee pursuant to a written agreement.
- (D) The filing of any request shall not be deemed complete and no activity shall be authorized by this general permit unless the filing fee has been paid in full.
- (E) The fee shall be paid by check or money order payable to the Department of Energy and Environmental Protection. Fees paid by state agencies may be paid by means of a service transfer or invoice.
- (F) All request for authorization fees are non-refundable.

- (2) Information Requirements and Request for Authorization Form**  
A request for authorization shall be filed on forms prescribed and provided by the commissioner and shall include but not be limited to the following:

- (A) Legal name, address, and telephone number of the requester. If the requester is an entity transacting business in Connecticut and is required to register with the Connecticut Secretary of the State, provide the exact name as registered with the Connecticut Secretary of the State.
- (B) Legal name, address, and telephone number of the owner of the property on which the subject activity is to take place.
- (C) Legal name, address, and telephone number of the requester's attorney or other representative, if applicable.
- (D) Legal name, address, and telephone number of any consultant(s) or engineer(s) retained by the requester to prepare the request for authorization or to design or construct the subject activity.
- (E) Location address of the site with respect to which the request for authorization is submitted.
- (F) Location Map - A depiction, on an 8.5" x 11" copy of the relevant portion of the most recent version of the United States Geologic Survey topographic map (Scale 1:24,000), of the exact location of the property at which such activity will be conducted.
- (G) A description of the present and intended use(s) of the property at which such activity will be conducted and the reason for conducting such activity.
- (H) A description of all natural and manmade features, including wetlands, watercourses, fish and wildlife habitat, floodplains, and structures and appurtenances thereto, potentially affected by the subject activity.
- (I) Site Plan - the site ("site plan") showing its boundaries, the location of the subject activity and section views, as appropriate, of the property at which such activity will be conducted, depicting the location and design of such activity, existing and proposed topography, the legal boundaries of such property, the location of wetland soil types, the location of tidal wetlands, watercourses, vernal pools, and coastal resources on and immediately adjacent to such property, the sequence of construction or other actions associated with the proposed activities, including placement and removal of any temporary fill or structures, the location of all erosion and sedimentation control measures, the location on such property where any excess materials resulting from construction at such property may be placed, a north arrow and distance scale, and a title block indicating the name of the requester, the name of the individual who prepared the plan, and the date(s) such plan was

prepared or revised. If such property is located in a floodplain, the plan shall also depict the location of any floodway, the elevation of the base flood, and, where applicable, the location of the stream channel encroachment line(s). The plan may incorporate existing natural resource maps and shall be of sufficient scale and detail to adequately depict the existing and proposed conditions of such property.

- (J) The signature of the requester and of the individual or individuals responsible for actually preparing the request for authorization, each of whom shall certify in writing as follows:

“I have personally examined and am familiar with the information submitted in this document and all attachments thereto, and I certify that, based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief. I certify that this request for authorization is on complete and accurate forms as prescribed by the commissioner without alteration of their text. I certify that a complete copy of this request for authorization, including all documents attached thereto, was sent by regular or certified mail or was hand delivered to the municipal wetlands agency, zoning commission, planning commission or combined planning and zoning commission, and conservation commission of each municipality which is or may be affected by the subject activity. I understand that a false statement made in the submitted information may be punishable as a criminal offense, in accordance with section 22a-6 of the General Statutes, pursuant to section 53a-157b of the General Statutes, and in accordance with any other applicable statute.”

**(d) *Where to File a Request for Authorization***

The original and one copy of a request for authorization shall be filed with the commissioner at the following address:

CENTRAL PERMIT PROCESSING UNIT  
DEPARTMENT OF ENERGY & ENVIRONMENTAL PROTECTION  
79 ELM STREET  
HARTFORD, CT 06106-5127

**(e) *Copy to Municipality***

A copy of such request for authorization shall be filed before the date that the activity is proposed to be initiated with the inland wetlands agency, zoning commission, planning commission or combined planning and zoning commission, and conservation commission of each municipality which is or may be affected by the subject activity.



**(f) Additional Information**

The commissioner may require a requester to submit additional information, which the commissioner reasonably deems necessary to evaluate the consistency of the subject activity with the requirements for authorization under this general permit.

**(g) Action by Commissioner**

- (1) The commissioner may reject without prejudice a request for authorization if it is determined that it does not satisfy the requirements of Section 4(c) of this general permit or more than thirty (30) days have elapsed since the commissioner requested that the requester submit additional information or the required fee and the requester has not submitted such information or fee. Any request for authorization refiled after such a rejection shall be accompanied by the fee specified in Section 4(c)(1) of this general permit.
- (2) The commissioner may disapprove a request for authorization if it is found that the subject activity is inconsistent with the requirements for authorization under Section 3 of this general permit, or for any other reason provided by law.
- (3) Disapproval of a request for authorization under this subsection shall constitute notice to the requester that the subject activity may not lawfully be conducted or maintained without the issuance of an individual permit.
- (4) The commissioner may approve a request for authorization with reasonable conditions. If the commissioner approves a request for authorization with conditions, the permittee shall be bound by such conditions as if they were a part of this general permit.
- (5) Rejection, disapproval, or approval of a request for authorization shall be in writing.

**Section 5. Conditions of This General Permit**

**(a) Operating Conditions**

- (1) A permittee shall assure that each action with respect to the authorization under this general permit is, as applicable, constructed and maintained in accordance with the *Connecticut Guidelines for Soil Erosion and Sediment Control*, published by the Connecticut Council on Soil and Water Conservation pursuant to section 22a-328 of the General Statutes and in accordance with the 2004 Connecticut Stormwater Quality Manual.
- (2) All excavated or dredged material shall be staged and managed in accordance with all applicable laws including but not limited to the provisions of the General Permit for Contaminated Soil and/or Sediment



Management (Staging and Transfer) (DEP-SW-GP-001).

**(b) Reporting and Record Keeping Requirements**

**(1) Contractor Notification**

If the authorized activity will be constructed by a person(s) under contract to the permittee, the permittee shall (A) give a copy of this general permit and of permittee's approval of authorization hereunder to such contractor(s) prior to the start of construction, and (B) for one year after completion of the authorized activity, retain a written receipt for such copy, signed and dated by such contractor(s).

**(2) Record Keeping and Reporting of Maintenance Activities**

With respect to maintenance plans as described in Section 3(a) (1), (2), (3), and (4) of this general permit and authorized hereunder, the permittee shall maintain a record of each action undertaken pursuant to such plan. Such record shall include the date(s) each such action was undertaken, a brief description thereof, the quantities of any material placed or removed in connection therewith, and the location of such activity. The permittee shall submit a copy of such record to the commissioner on January 30th of the year after the date the commissioner approved permittee's request for authorization, and shall continue every January 30th thereafter to submit to the commissioner a copy of such record, as it applies, to the preceding twelve months.

**(c) Recording and Reporting Violations**

Within 48 hours after the permittee learns of a violation of this general permit, the permittee shall report same in writing to the commissioner. Such report shall be sent to the following address:

INLAND WATER RESOURCES DIVISION  
DEPARTMENT OF ENERGY AND ENVIRONMENTAL PROTECTION  
79 ELM STREET  
HARTFORD, CT 06106-5127

And include the following information:

- (1) the provision(s) of this general permit that has been violated;
- (2) the date and time the violation(s) was first discovered and by whom;
- (3) the cause of the violation(s), if known;
- (4) if the violation(s) has ceased, the duration of the violation(s) including exact date(s) and time(s) it was corrected;
- (5) if the violation(s) has not ceased, the anticipated date when it will be corrected;

- (6) steps taken and steps planned to prevent a reoccurrence of the violation(s) and the date(s) such steps were implemented or will be implemented;
- (7) the signature of the permittee and of the individual(s) responsible for actually preparing such report, each of whom shall certify as follows:

“I have personally examined and am familiar with the information submitted in this document and all attachments thereto, and I certify that, based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief. I understand that a false statement made in this document or its attachments may be punishable as a criminal offense, in accordance with section 22a-6 of the General Statutes, pursuant to section 53a-157b of the General Statutes, and in accordance with any other applicable statute.”

**(d) *Modification of Authorized Activity***

In conducting and maintaining the activity authorized by this general permit, the permittee shall not make any alteration, except a de minimis alteration which does not change the footprint, character and nature of the regulated impacts.

**(e) *Completion of Authorized Activity***

If the permittee does not complete the authorized activity within five years after the date of the applicable authorization, said authorization shall be null and void.

## **Section 6. General Conditions**

**(a) *Reliance on Registration***

When evaluating a registration, the commissioner relies on information provided by the registrant. If such information proves to be false or incomplete, the authorization issued under this general permit may be suspended or revoked in accordance with law, and the commissioner may take any other legal action provided by law.

**(b) *Duty to Correct and Report Violations***

Upon learning of a violation of a condition of this general permit, a permittee shall immediately take all reasonable action to determine the cause of such violation, correct such violation and mitigate its results, prevent further such violation, and report in writing in accordance with Section 5(c) of this general permit.

**(c) *Duty to Provide Information***

If the commissioner requests any information pertinent to the authorized activity or to determine compliance with this general permit or with the

permittee's approval of request for authorization, the permittee shall provide such information in writing within thirty (30) days of such request. Such information shall be certified in accordance with Section 6(d) of this general permit.

**(d) *Certification of Documents***

Any document, including but not limited to any notice, which is submitted to the commissioner under this general permit shall be signed by, as applicable, the registrant or the permittee in accordance with section 22a-430-3(b)(2) of the Regulations of Connecticut State Agencies, and by the individual or individuals responsible for actually preparing such document, each of whom shall certify in writing as follows:

“I have personally examined and am familiar with the information submitted in this document and all attachments thereto, and I certify that, based on reasonable investigation, including my inquiry of those individuals responsible for obtaining the information, the submitted information is true, accurate and complete to the best of my knowledge and belief. I understand that a false statement made in the submitted information may be punishable as a criminal offense, in accordance with section 22a-6 of the General Statutes, pursuant to section 53a-157b of the General Statutes, and in accordance with any other applicable statute.”

**(e) *Date of Filing***

For purposes of this general permit, the date of filing with the commissioner of any document is the date such document is received by the commissioner. The word "day" as used in this general permit means the calendar day; if any date specified in the general permit falls on a Saturday, Sunday, or legal holiday, such deadline shall be the next business day.

**(f) *False Statements***

Any false statement in any information submitted pursuant to this general permit or the request for authorization may be punishable as a criminal offense, in accordance with section 22a-6, under section 53a-157b of the General Statutes.

**(g) *Correction of Inaccuracies***

Within fifteen (15) days after the date a permittee becomes aware of a change in any information in any material submitted pursuant to this general permit, or becomes aware that any such information is inaccurate or misleading or that any relevant information has been omitted, such permittee shall correct the inaccurate or misleading information or supply the omitted information in writing to the commissioner. Such information shall be certified in accordance with Section 6(d) of this general permit. The provisions of this subsection shall apply both while a request for approval of request for authorization is pending and after the commissioner has approved such request.

**(h) *Transfer of Authorization***

Authorization under this general permit is transferable only in accordance with the provisions of section 22a-60 of the General Statutes.

**(i) *Other Applicable Law***

Nothing in this general permit shall relieve the permittee of the obligation to comply with any other applicable federal, state and local law, including but not limited to the obligation to obtain any other authorizations required by such law.

**(j) *Other Rights***

This general permit is subject to and does not derogate any present or future rights or powers of the State of Connecticut and conveys no rights in real or personal property nor any exclusive privileges, and is subject to all public and private rights and to any federal, state, and local laws pertinent to the property or activity affected by such general permit. In conducting any activity authorized hereunder, the permittee may not cause pollution, impairment, or destruction of the air, water, or other natural resources of this state. The issuance of this general permit shall not create any presumption that this general permit should or will be renewed.

## **Section 7. Commissioner's Powers**

**(a) *Abatement of Violations***

The commissioner may take any action provided by law to abate a violation of this general permit, including the commencement of proceedings to collect penalties for such violation. The commissioner may, by summary proceedings or otherwise and for any reason provided by law, including violation of this general permit, revoke a permittee's authorization hereunder in accordance with sections 22a-3a-2 through 22a-3a-6 of the Regulations of Connecticut State Agencies, inclusive. Nothing herein shall be construed to affect any remedy available to the commissioner by law.

**(b) *General Permit Revocation, Suspension, or Modification***

The commissioner may, for any reason provided by law, by summary proceedings or otherwise, revoke or suspend this general permit or modify it to establish any appropriate conditions, schedules of compliance, or other provisions which may be necessary to protect human health and the environment.

(c) ***Filing of an Individual Permit Application***

If the commissioner notifies a permittee in writing that such permittee must obtain an individual permit to continue lawfully conducting the activity authorized by this general permit, the permittee may continue conducting such activity only if the permittee files an application for an individual permit within sixty (60) days of receiving the commissioner's notice. While such application is pending before the commissioner, the permittee shall comply with the terms and conditions of this general permit and the subject approval of registration. Nothing herein shall affect the commissioner's power to revoke a permittee's authorization under this general permit at any time.

Issued Date: April 2, 2014

Susan Whalen /s/ for

Macky McCleary

Deputy Commissioner

This is a true and accurate copy of the general permit executed on **April 2, 2014** by the Department of Energy and Environmental Protection.



## Compliance Certification Form

The following certification must be signed by the licensee working in consultation with a Connecticut-licensed design professional and must be submitted to the address indicated at the end of this form within ninety (90) days of completion of the authorized work.

1. Licensee Name: <u>CT DEEP ( BCS)</u>	
DEEP License Number(s): <u>202007197-FM</u>	
Municipality in which project is occurring: <u>Thomaston and Watertown</u>	
2. <b>Check one:</b>	
(a) <input type="checkbox"/> "I certify that the final site conditions and / or structures are in general conformance with the approved site plans". Identify and describe any deviations and attach to this form.	
(b) <input type="checkbox"/> "The final site conditions and / or structures are not in general conformance with the approved site plans. The enclosed "as-built" plans note the modifications".	
3. "I understand that any false statement in this certification is punishable as a criminal offence under section 53a-157b of the General Statutes and under any other applicable law."	
_____ Signature of Licensee	_____ Date
_____ Name of Licensee (print or type)	
_____ Signature of CT-Licensed Design Professional	_____ Date
_____ Name of CT-Licensed Design Professional (print or type)	
_____ Professional License Number (if applicable)	Affix Stamp Here
<ul style="list-style-type: none"> <li>• As-built plans shall include: elevations or tidal datums, as applicable, and structures, including any proposed elevation views and cross sections included in the approved license plans. Such as-built plans shall be the original ones and be signed and sealed by an engineer, surveyor or architect, as applicable, who is licensed in the State of Connecticut.</li> <li>• The Licensee will be notified by staff of the Land and Water Resources Division (LWRD) if further compliance review is necessary. Lack of response by LWRD staff does not imply compliance.</li> </ul>	
<p>Submit this completed form to :</p> <p><b>Regulatory Section</b>  <b>Department of Energy and Environmental Protection</b>  <b>Land &amp; Water Resources Division</b>  <b>79 Elm Street</b>  <b>Hartford, CT 06106-5127</b></p>	