



# **Volume 2 of 2 Project Manual**

***Enfield Armory Kitchen and Latrine Renovation***  
**1635 King Street**  
**Enfield, CT**  
**Project No.: BI-Q-672C**

**CTARNG Tracking No.: EN-1301C**

**Prepared By:**  
***Architect: ID3A, LLC***  
***655 Winding Brook Drive***  
***Glastonbury, CT 06033***

**Josh Geballe – Commissioner**

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

**Project Manual Date: July 10, 2018**



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<b>Section No.</b>	<b>Title</b>		<b>Page Count</b>
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<b>50 20 00</b>	Environmental Assessment Information			<input checked="" type="checkbox"/>
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<b>50 50 00</b>	Elevator Agreement			<input checked="" type="checkbox"/>
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<b>50 60 00</b>	FM Global Checklist For Roofing Systems			<input checked="" type="checkbox"/>
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<b>50 70 00</b>	Statement of Special Inspections	2		<input type="checkbox"/>
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<b>50 80 00</b>	Other Information:			<input checked="" type="checkbox"/>
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**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. This section is intended to supplement the requirements of Division 01 requirements. For any conflicting requirements for minimum quantities or quality levels between this Section and Division 01, comply with the most stringent requirement.

**1.2 SUMMARY**

- A. This Section includes the following when associated with Divisions 21, 22, and 23 work:
  - 1. Permits and fees, code requirements, work under other contracts.
  - 2. Work restrictions.
  - 3. Specification formats and conventions.
  - 4. Request for information.
  - 5. Coordination.
  - 6. Conflicting requirements.
  - 7. Quality assurance and control.
  - 8. Product delivery, storage, and handling.
  - 9. Product warranties.
  - 10. Submittals.
  - 11. Product selection procedures.
  - 12. Product interoperability requirements.
  - 13. General execution of project scope of work.
  - 14. Record drawings.
  - 15. Demonstration and training.

- B. Related Sections include the following:
  - 1. Division 01 Sections.

**1.3 PERMITS AND FEES**

- A. Give all necessary notices, obtain all permits; pay all government and state sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Project scope of 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 inspections for Project scope of work and deliver a copy to the Architect/Engineer before request for acceptance and final payment for the Project scope of work.

**1.4 CODE REQUIREMENTS**

- A. Project Code: Confirm the codes in effect at the time of permitting.
- B. Project Legislative Requirements: Confirm the State and Local Legislations in effect at the time of permitting or those that affect construction.
- C. Compliance: Comply with all codes and legislations applicable to the project, including energy related:
  - 1. Means and Methods
  - 2. Equipment and Devices.
  - 3. Materials and Work Product.

# **Section 50 30 00 Hazardous Building Materials Inspection and Inventory**

15-0425-11  
May 29, 2014



Rick Voelker, P.E.  
Principal  
Fletcher Thompson, Inc.  
855 Main Street, 8<sup>th</sup> Floor  
Bridgeport, CT 06601-1501

Re: **Hazardous Building Materials Inspection Report  
CTARNG Vision 2020 Project #8 (EN1301) Enfield Armory Renovations  
1635 King Street, Enfield, Connecticut**

Dear Mr. Voelker:

In accordance with our proposal dated October 9, 2013, Tighe & Bond has completed a Hazardous Building Materials Inspection (HBMI) for the hazardous materials storage shed at the Connecticut Army National Guard Property located at 1635 King Street in Enfield, CT (site). Based on the information you provided, this project involves demolition of the existing structure. The purpose of the inspection was to determine if hazardous building materials are associated with building components that will be impacted during proposed demolition activities.

## **Inspection Summary**

The HBMI was conducted by State of Connecticut licensed inspector, Justin Proto of Tighe & Bond on April 24, 2014. A copy of the inspector's license is included in Appendix A. The HBMI was limited to the materials slated to be impacted by proposed demolition activities associated with the HazMat shed. The inspection included sampling of suspect asbestos containing materials (ACM). Caulking was also sampled for analysis of polychlorinated biphenyls (PCBs). An evaluation of existing electrical equipment for asbestos containing materials, PCBs, DEHP, or other hazardous materials was conducted as part of the inspection.

## **Suspect Asbestos-Containing Material Sampling**

A total of 5 different types of suspect asbestos containing materials were observed and sampled during this inspection. Sampled materials are listed in Table 1 (Appendix B). Samples were collected of each suspect material in accordance with the United States Environmental Protection Agency (EPA) requirements for asbestos identification. Samples were submitted to EMSL Laboratories in Wallingford, Connecticut for asbestos analysis via Polarized Light Microscopy (PLM) using EPA approved protocol in accordance with accreditation of the National Institute of Standards and Technology (NIST).

During inspection activities the sample locations, types of material, and quantities were recorded. Homogenous materials were noted when observed.

## **PCB Sampling of Caulk Compounds**

Samples were collected of caulking compounds observed during the inspection. Two different types of caulks were observed. Samples of each different type of material were collected in accordance with the EPA sampling guidelines. These samples were submitted to Phoenix Laboratories for analysis of PCBs utilizing the EPA 3540C Soxhlet Extraction and SW 846 8082 analytical method.



## Findings and Conclusions

### Asbestos Sampling Results

During the course of the inspection, a total of 10 bulk samples of suspect ACM were collected and 10 samples were analyzed by PLM based on the “stop on first positive” request from the laboratory.

EPA defines any material containing more than 1% asbestos as ACM. None of the materials sampled were found to be ACM.

Refer to Table 1 for a summary of materials sampled and locations. Laboratory analytical reports for asbestos sampling are provided in Appendix C.

If additional materials are encountered during upgrade activities that were not previously sampled then they would need to be sampled to determine if it is an asbestos containing material or should be assumed to be asbestos containing.

All regulated friable and non-friable ACM must be removed prior to renovation or demolition activities. A State of Connecticut Licensed Asbestos Abatement Contractor must be retained to perform removal work. Visual inspections must be performed within each abatement area at the completion of the abatement work. The visual inspection must be performed by a State of Connecticut Licensed Asbestos Project Monitor. The abatement areas must meet final visual inspection criteria prior to renovation or demolition activities. Re-occupancy air monitoring is required before any entry of any person into the work area.

The Asbestos Abatement Contractor must submit a notice of asbestos abatement to the State of Connecticut Department of Health post marked or hand delivered 10 days prior to the commencement of any asbestos abatement activities involving the abatement of greater than 10 linear feet or 25 square feet of asbestos containing materials.

### PCB Sample Results for Caulk, Glazing Compounds

A total of six samples were submitted for analysis of PCBs (2 different types of materials). An interior door frame caulk and an exterior door frame caulk were the only suspect PCB containing materials identified. None of the sampled materials were found to contain PCBs in concentrations greater than 1 ppm.

Source materials containing PCBs at concentrations greater than 50 ppm are regulated by EPA and materials greater than 1 ppm by the Connecticut Department of Energy and Environmental Protection (CTDEEP). Materials with PCB concentrations less than or equal to 1 ppm are not regulated and can be disposed of as general construction waste. Refer to Table 2 for a detailed list of materials sampled for PCBs. Laboratory analytical reports for PCB sampling are provided in Appendix D.

### Visual Inspection for Universal Wastes

A visual inspection for lighting ballasts, transformers, electrical switches, small electrical motor capacitors and other items that could contain PCBs or DEHP was conducted. No universal wastes were identified within the HazMat shed.

If you have any questions regarding this letter report, please contact James Webb at (860)704-4783/[jtwebb@tighebond.com](mailto:jtwebb@tighebond.com) or James Olsen at (860)704-4761 [jtolsen@tighebond.com](mailto:jtolsen@tighebond.com).

Very truly yours,  
**TIGHE & BOND, INC.**

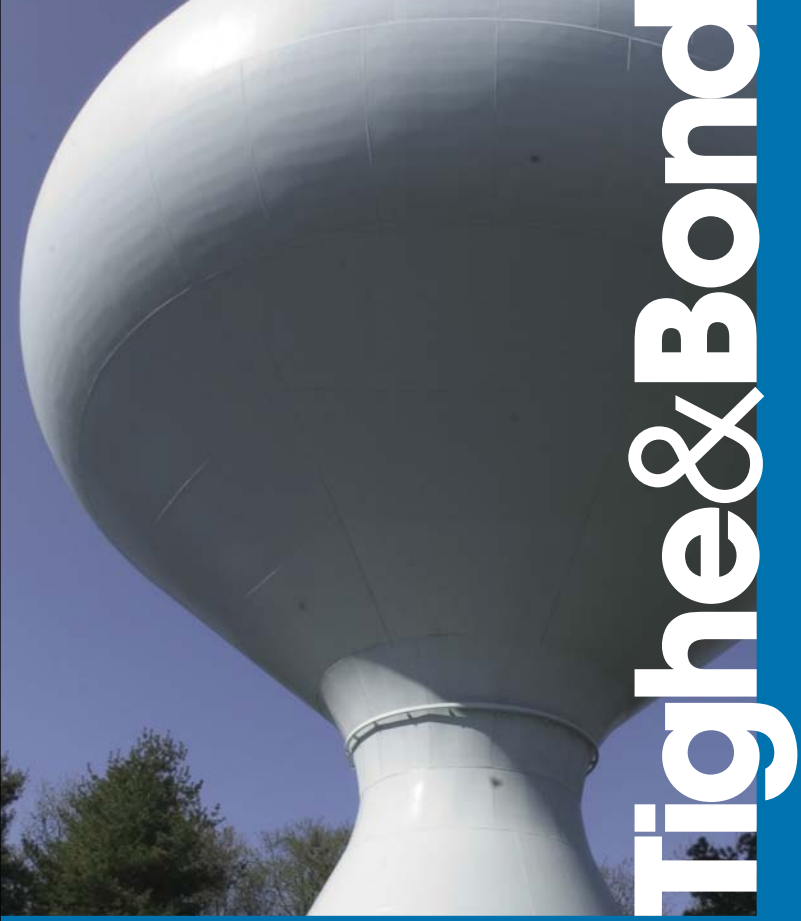


James Webb  
Project Environmental Compliance Specialist



James T. Olsen, LEP  
Vice President

Enclosures:   **Appendix A** - Inspector Licenses  
                  **Appendix B** - Table 1 Summary of Non-Asbestos Containing Materials  
                                  Table 2 Summary of PCB Sampling Results  
                  **Appendix C** - EMSL Asbestos Laboratory Analytical Reports  
                  **Appendix D** - Phoenix Laboratory Analytical Reports



# Tighe & Bond





# Tighe & Bond

Table 1  
 Summary of Non-Asbestos Containing Materials  
 Enfield Armory  
 Enfield, CT

Sampling Date: 4/24/2014

<b>Sample #</b>	<b>Material</b>	<b>Color</b>	<b>Description</b>	<b>Room</b>	<b>Result</b>
4-24 JP 01 & 02	CMU Mortar	Grey	Walls	Interior	None-Detected
4-24 JP 03 & 04	Interior Door Frame Caulk	White	Door Frame	Interior	None-Detected
4-24 JP 05 & 06	Top Layer Roofing	White/Black	Roofing	Exterior	None-Detected
4-24 JP 07 & 08	Bottom Layer Roofing	Grey/Black	Roofing	Exterior	None-Detected
4-24 JP 09 & 10	Exterior Door Frame Caulk	Grey	Door Frame	Exterior	None-Detected

TABLE 2  
Summary of PCB Sampling Results  
Enfield Armory  
Enfield, CT

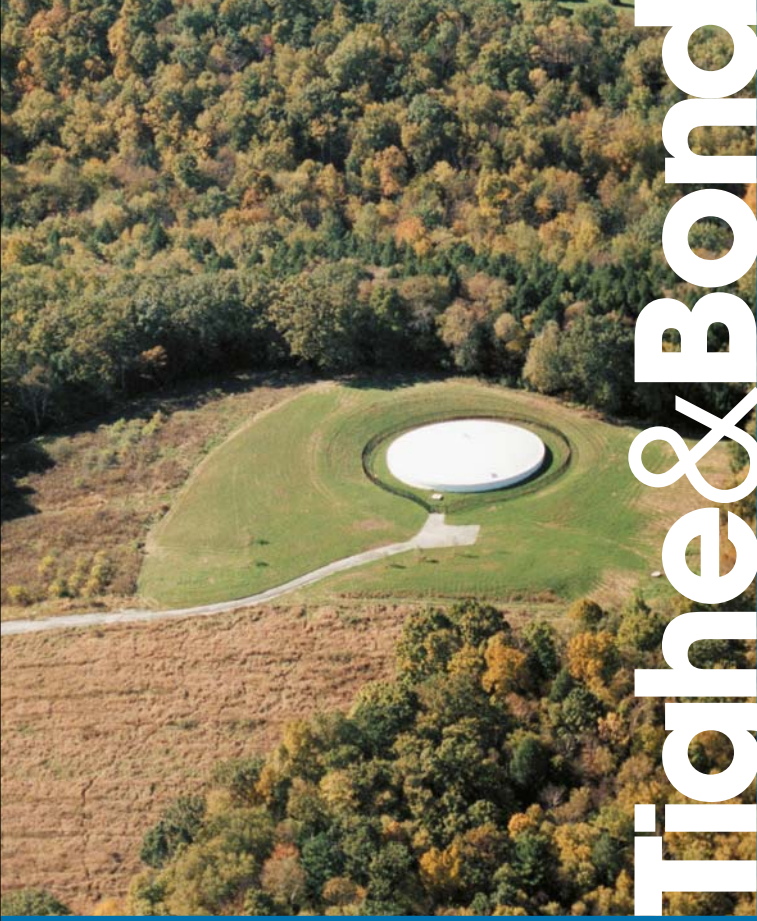
**PCB Sampling Date:** 4/24/2014

<b>Sample #</b>	<b>Description</b>	<b>Location</b>	<b>Result (ppm)</b>	<b>Notes</b>
4-24 PCB-01	Interior Door Frame Caulk	Interior	ND <0.78	Found at Interior Door frame
4-24 PCB-02	Interior Door Frame Caulk	Interior	ND <0.75	Found at Interior Door frame
4-24 PCB-03	Interior Door Frame Caulk	Interior	ND<0.41	Found at Interior Door frame
4-24 PCB-04	Exterior Door Frame Caulk	Exterior	ND<0.77	Found at Exterior Door frame
4-24 PCB-05	Exterior Door Frame Caulk	Exterior	ND<0.80	Found at Exterior Door frame
4-24 PCB-06	Exterior Door Frame Caulk	Exterior	ND<0.76	Found at Exterior Door frame

**LEGEND**

ppm = parts per million

ND = not detected above laboratory detection limits



# Tighe & Bond

**EMSL Analytical, Inc.**

29 North Plains Highway, Unit # 4, Wallingford, CT 06492

Phone/Fax: 203-284-5948 / (203) 284-5978

<http://www.EMSL.com>[wallingfordlab@emsl.com](mailto:wallingfordlab@emsl.com)

EMSL Order: 241401443

CustomerID: TIGH62

CustomerPO:

ProjectID:

Attn: **James Webb  
Tighe & Bond  
213 Court Street  
Suite 900  
Middletown, CT 06457**

Phone: (860) 704-4760  
Fax: (860) 704-4775  
Received: 04/24/14 3:45 PM  
Analysis Date: 5/1/2014  
Collected: 4/24/2014

Project: ENFIELD ARMORY

## Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
4-24 JP 01 241401443-0001	HAZ shed - CMU mortar	Gray Non-Fibrous Homogeneous	<1% Cellulose	25% Quartz 45% Ca Carbonate 30% Non-fibrous (other)	None Detected
4-24 JP 02 241401443-0002	HAZ shed - CMU mortar	Gray Non-Fibrous Homogeneous		20% Quartz 30% Ca Carbonate 50% Non-fibrous (other)	None Detected
4-24 JP 03 241401443-0003	HAZ shed - white door frame caulk	White Non-Fibrous Homogeneous	<1% Cellulose	25% Ca Carbonate 75% Non-fibrous (other)	None Detected
4-24 JP 04 241401443-0004	HAZ shed - white door frame caulk	White Non-Fibrous Homogeneous		100% Non-fibrous (other)	None Detected
4-24 JP 05 241401443-0005	HAZ shed - top layer roofing	White/Black Fibrous Homogeneous	60% Cellulose	20% Ca Carbonate 20% Non-fibrous (other)	None Detected
4-24 JP 06 241401443-0006	HAZ shed - top layer roofing	Black Non-Fibrous Homogeneous	45% Cellulose	55% Non-fibrous (other)	None Detected
4-24 JP 07 241401443-0007	HAZ shed - bottom layer roofing	Gray/Black Fibrous Homogeneous	25% Cellulose	75% Non-fibrous (other)	None Detected
4-24 JP 08 241401443-0008	HAZ shed - bottom layer roofing	Gray/Black Fibrous Homogeneous	35% Cellulose	65% Non-fibrous (other)	None Detected

Analyst(s)

Kristin Lopez (5)

William Shedrawy (2)

Renaldo Drakes (3)

Gloria V. Oriol, Laboratory Manager  
or other approved signatory

EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. Non-friable organically bound materials present a problem matrix and therefore EMSL recommends gravimetric reduction prior to analysis. Samples received in good condition unless otherwise noted. Estimated accuracy, precision and uncertainty data available upon request. Unless requested by the client, building materials manufactured with multiple layers (i.e. linoleum, wallboard, etc.) are reported as a single sample. Reporting limit is 1%

Samples analyzed by EMSL Analytical, Inc. Wallingford, CT NVLAP Lab Code 200700-0.

Initial report from 05/01/2014 19:18:34



# EMSL Analytical, Inc.

29 North Plains Highway, Unit # 4, Wallingford, CT 06492  
Phone/Fax: 203-284-5948 / (203) 284-5978  
<http://www.EMSL.com> [wallingfordlab@emsl.com](mailto:wallingfordlab@emsl.com)

EMSL Order: 241401443  
CustomerID: TIGH62  
CustomerPO:  
ProjectID:

Attn: **James Webb  
Tighe & Bond  
213 Court Street  
Suite 900  
Middletown, CT 06457**  
Project: ENFIELD ARMORY

Phone: (860) 704-4760  
Fax: (860) 704-4775  
Received: 04/24/14 3:45 PM  
Analysis Date: 5/1/2014  
Collected: 4/24/2014

## Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
4-24 JP 09 241401443-0009	Grey door frame caulk	Gray Non-Fibrous Homogeneous		25% Ca Carbonate 75% Non-fibrous (other)	None Detected
4-24 JP 10 241401443-0010	Grey door frame caulk	Gray Non-Fibrous Homogeneous		20% Ca Carbonate 80% Non-fibrous (other)	None Detected

Analyst(s) \_\_\_\_\_

Kristin Lopez (5) *William Shedrawy (2)*  
Renaldo Drakes (3)

Gloria V. Oriol, Laboratory Manager  
or other approved signatory

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Samples analyzed by EMSL Analytical, Inc. Wallingford, CT NVLAP Lab Code 200700-0.

Initial report from 05/01/2014 19:18:34



# Tighe & Bond



Wednesday, April 30, 2014

Attn: Mr James Webb  
Tighe & Bond  
213 Court St  
Suite 900  
Middletown, CT 06457

Project ID: ENFIELD ARMORY  
Sample ID#s: BG37138 - BG37143

This laboratory is in compliance with the NELAC requirements of procedures used except where indicated.

This report contains results for the parameters tested, under the sampling conditions described on the Chain Of Custody, as received by the laboratory.

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

A scanned version of the COC form accompanies the analytical report and is an exact duplicate of the original.

If you have any questions concerning this testing, please do not hesitate to contact Phoenix Client Services at ext. 200.

Sincerely yours,

A handwritten signature in black ink that reads "Phyllis Shiller".

Phyllis Shiller  
Laboratory Director

NELAC - #NY11301  
CT Lab Registration #PH-0618  
MA Lab Registration #MA-CT-007  
ME Lab Registration #CT-007  
NH Lab Registration #213693-A,B

NJ Lab Registration #CT-003  
NY Lab Registration #11301  
PA Lab Registration #68-03530  
RI Lab Registration #63  
VT Lab Registration #VT11301





Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37138

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-01 WHITE INT DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	780	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	86		%	04/28/14	AW	30 - 150 %
% TCMX	70		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

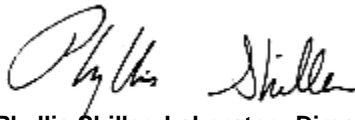
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

This report must not be reproduced except in full as defined by the attached chain of custody.



**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37139

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-02 WHITE INT DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	750	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	96		%	04/28/14	AW	30 - 150 %
% TCMX	101		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

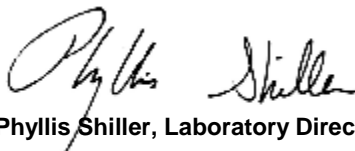
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

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**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37140

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-03 WHITE INT DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	410	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	78		%	04/28/14	AW	30 - 150 %
% TCMX	86		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

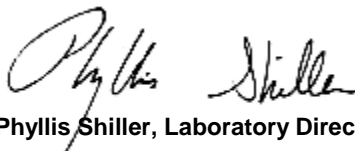
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

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**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37141

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-04 GREY ING DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	770	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	117		%	04/28/14	AW	30 - 150 %
% TCMX	104		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

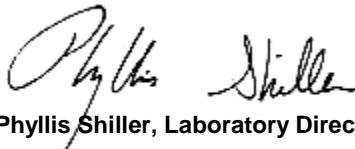
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

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**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**





Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37142

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-05 GREY EXT DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/29/14	AW	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	800	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	115		%	04/28/14	AW	30 - 150 %
% TCMX	104		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

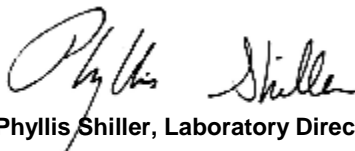
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

This report must not be reproduced except in full as defined by the attached chain of custody.



**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37143

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-06 GREY DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	760	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	120		%	04/28/14	AW	30 - 150 %
% TCMX	108		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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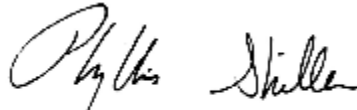
RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.  
This report must not be reproduced except in full as defined by the attached chain of custody.



**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# QA/QC Report

April 30, 2014

## QA/QC Data

SDG I.D.: GBG37138

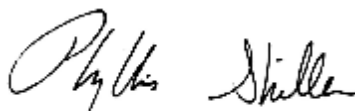
Parameter	Blank	LCS %	LCSD %	LCS RPD	MS %	MSD %	MS RPD	% Rec Limits	% RPD Limits
QA/QC Batch 272545, QC Sample No: BG36808 (BG37138, BG37139, BG37140, BG37141, BG37142, BG37143)									
<u>Polychlorinated Biphenyls - Solid</u>									
PCB-1016	ND	83	91	9.2				40 - 140	30
PCB-1221	ND							40 - 140	30
PCB-1232	ND							40 - 140	30
PCB-1242	ND							40 - 140	30
PCB-1248	ND							40 - 140	30
PCB-1254	ND							40 - 140	30
PCB-1260	ND	89	97	8.6				40 - 140	30
PCB-1262	ND							40 - 140	30
PCB-1268	ND							40 - 140	30
% DCBP (Surrogate Rec)	87	88	97	9.7				30 - 150	30
% TCMX (Surrogate Rec)	82	86	95	9.9				30 - 150	30

Comment:

The MS/MSD could not be reported due to matrix interference in the unspiked sample. LCS/LCSD recoveries were within QA/QC limits.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

- RPD - Relative Percent Difference
- LCS - Laboratory Control Sample
- LCSD - Laboratory Control Sample Duplicate
- MS - Matrix Spike
- MS Dup - Matrix Spike Duplicate
- NC - No Criteria
- Intf - Interference

  
 Phyllis Shiller, Laboratory Director  
 April 30, 2014

Criteria: None

State: CT

# Sample Criteria Exceedences Report

## GBG37138 - TIGHE

SampNo	Acode	Phoenix Analyte	Criteria	Result	RL	Criteria	RL Criteria	Analysis Units
--------	-------	-----------------	----------	--------	----	----------	----------------	-------------------

\*\*\* No Data to Display \*\*\*

Phoenix Laboratories does not assume responsibility for the data contained in this report. It is provided as an additional tool to identify requested criteria exceedences. All efforts are made to ensure the accuracy of the data (obtained from appropriate agencies). A lack of exceedence information does not necessarily suggest conformance to the criteria. It is ultimately the site professional's responsibility to determine appropriate compliance.

# Reasonable Confidence Protocol Laboratory Analysis QA/QC Certification Form

**Laboratory Name:** Phoenix Environmental Labs, Inc. **Client:** Tighe & Bond

**Project Location:** ENFIELD ARMORY **Project Number:**

**Laboratory Sample ID(s):** BG37138, BG37139, BG37140, BG37141, BG37142, BG37143

**Sampling Date(s):** 4/24/2014

**RCP Methods Used:**

- 1311/1312     6010     7000     7196     7470/7471     8081     EPH     TO15  
 8082     8151     8260     8270     ETPH     9010/9012     VPH

1.	For each analytical method referenced in this laboratory report package, were all specified QA/QC performance criteria followed, including the requirement to explain any criteria falling outside of acceptable guidelines, as specified in the CT DEP method-specific Reasonable Confidence Protocol documents?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
1a.	Were the method specified preservation and holding time requirements met?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
1b.	EPH and VPH methods only: Was the VPH or EPH method conducted without significant modifications (see section 11.3 of respective RCP methods)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
2.	Were all samples received by the laboratory in a condition consistent with that described on the associated Chain-of-Custody document(s)?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
3.	Were samples received at an appropriate temperature (< 6 Degrees C)?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
4.	Were all QA/QC performance criteria specified in the Reasonable Confidence Protocol documents achieved?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
5a.	Were reporting limits specified or referenced on the chain-of-custody?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
5b.	Were these reporting limits met?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
6.	For each analytical method referenced in this laboratory report package, were results reported for all constituents identified in the method-specific analyte lists presented in the Reasonable Confidence Protocol documents?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
7.	Are project-specific matrix spikes and laboratory duplicates included in the data set?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> NA

**Note:** For all questions to which the response was "No" (with the exception of question #5a, #7), additional information must be provided in an attached narrative. If the answer to question #1, #1A or 1B is "No", the data package does not meet the requirements for "Reasonable Confidence".

**I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete.**

Authorized  
Signature:

Ethan Lee

Date: Wednesday, April 30, 2014

Printed Name: Ethan Lee

Position: Project Manager



**Environmental Laboratories, Inc.**  
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
Tel. (860) 645-1102 Fax (860) 645-0823



# RCP Certification Report

April 30, 2014

SDG ID.: GBG37138

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## PCB Narration

Were all QA/QC performance criteria specified in the Reasonable Confidence Protocol documents achieved? Yes.

**Instrument:** Au-ecd1 04/28/14-1 (BG37141, BG37142, BG37143)

8082 Narration:

The initial calibration RSD for the compound list was less than 15% except for the following compounds: none

The continuing calibration standards were within acceptance criteria except for the following compounds: none

**Printed Name** Adam Werner  
**Position:** Chemist  
**Date:** 4/28/2014

**Instrument:** Au-ecd3 04/28/14-1 (BG37139, BG37140)

8082 Narration:

The initial calibration RSD for the compound list was less than 15% except for the following compounds: none

The continuing calibration standards were within acceptance criteria except for the following compounds: none

**Printed Name** Adam Werner  
**Position:** Chemist  
**Date:** 4/28/2014

**Instrument:** Au-ecd5 04/28/14-1 (BG37138)

8082 Narration:

The initial calibration RSD for the compound list was less than 15% except for the following compounds: none

The continuing calibration standards were within acceptance criteria except for the following compounds: none

**Printed Name** Adam Werner  
**Position:** Chemist  
**Date:** 4/28/2014

**QC Comments:** QC Batch 272545 04/24/14 (BG37138, BG37139, BG37140, BG37141, BG37142, BG37143)

The MS/MSD could not be reported due to matrix interference in the unspiked sample. LCS/LCSD recoveries were within QA/QC limits.





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# RCP Certification Report

April 30, 2014

SDG I.D.: GBG37138

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## QC (Batch Specific)

----- Sample No: BG36808, QA/QC Batch: 272545 -----

All LCS recoveries were within 40 - 140 with the following exceptions: None.

All LCSD recoveries were within 40 - 140 with the following exceptions: None.

All LCS/LCSD RPDs were less than 30% with the following exceptions: None.

## Temperature Narration

The samples were received at 6C with cooling initiated.  
(Note acceptance criteria is above freezing up to 6°C)

# CHAIN OF CUSTODY RECORD

587 East Middle Turnpike, P.O. Box 370, Manchester, CT 06040  
 Email: info@phoenixlabs.com Fax (860) 645-0823  
**Client Services (860) 645-8726**



Customer: Tigne & Bond

Address: 213 Court St. Suite 900  
Middlesex, CT

Client Sample - Information - Identification

Sampler's Signature: [Signature] Date: 4-25-14

Matrix Code: SD  
 DW=Drinking Water GW=Ground Water SW=Surface Water WW=Waste Water  
 RW=Raw Water SE=Sediment SL=Sludge S=Soil SD=Solid W=Wipe  
 OIL=Oil B=Bulk L=Liquid

PHOENIX USE ONLY SAMPLE #	Customer Sample Identification	Sample Matrix	Date Sampled	Time Sampled
37138	4-24 PCB 01-	SD	4-24-14	AM
37139	White Ext. D.F.C.	SD		
37140	4-24 PCB 02-	SD		
37141	White Ext. D.F.C.	SD		
37142	4-24 PCB 03-	SD		
37143	White Ext. D.F.C.	SD		
	Gray Ext. D.F.C.	SD		
	4-24 PCB 04-	SD		
	Gray Ext. D.F.C.	SD		
	4-24 PCB 05-	SD		
	Gray Ext. D.F.C.	SD		
	4-24 PCB 06-	SD		
	Gray D.F.C.	SD		

Analysis Request

SOIL

- Soil VOA Vials [ methanol ] H<sub>2</sub>O
- GL Soil container ( ) oz
- 40 ml VOA Vial [ As is ] HCl
- GL Soil container ( ) oz
- GL Amber 100ml [ As is ] HCl
- PL As is [ 250ml ] [ 500ml ] [ 1000ml ]
- PL H<sub>2</sub>SO<sub>4</sub> [ 250ml ] [ 500ml ] [ 1000ml ]
- PL HNO<sub>3</sub> 250ml
- Bacteria Bottle

Relinquished by: [Signature] Accepted by: [Signature]

Date: 4/25/14 Time: 14:50  
4/25/14 14:40

Comments, Special Requirements or Regulations:

Turnaround:  
 1 Day  
 2 Days\*  
 3 Days\*  
 Standard  
 Other

\* SURCHARGE APPLIES \*

RI  Direct Exposure (Residential)  GW  Other

CT  RCP Cert  GW Protection  SW Protection  GA Mobility  GB Mobility  Residential DEC  I/C DEC  Other

MA  MCP Certification  GW-1  GW-2  GW-3  S-1  S-2  S-3  MWRA eSMART  Other

Data Format  Excel  PDF  GIS/Key  EQUIS  Other

Data Package  Tier II Checklist  Full Data Package\*  Phoenix Std Report  Other

State where samples were collected: CT

\* SURCHARGE APPLIES

Project P.O.:

This section MUST be completed with Bottle Quantities.

Cooler: Yes  No   
 Coolant: IPK  ICE   
 Temp 9 °C Pg of       
 Contact Options:  
 Fax:   
 Phone:   
 Email:

# Section 50 70 00 Statement of Special Inspections



655 Winding Brook Drive  
Glastonbury, CT 06033  
t: 860.657.2500 f: 860.657.0757

July 2, 2018

Peter B. McClure, P.E.  
Project Manager  
DAS/Division of Construction Services  
450 Columbus Blvd  
12<sup>th</sup> Floor North Tower  
Hartford, CT 06103

RE: BI-Q672C Enfield Armory Renovation

Peter,

To the best of my knowledge, information and belief, the project as described above does not require any Special Inspections during construction.

If you have any questions, please contact me.

Thank you,

A handwritten signature in blue ink that reads 'Stevanie Demko'. The signature is written in a cursive style.

Stevanie Demko



**1.5 WORK UNDER OTHER CONTRACTS**

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

**1.6 WORK RESTRICTIONS**

- A. Existing Utility Interruptions: 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:
  - 1. Notify Construction Manager or Owner not less than 10 days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Construction Manager's or Owner's written permission.

**1.7 REQUESTS FOR INFORMATION (RFIs)**

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  - 1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  - 1. Project name.
  - 2. Project number.
  - 3. Date.
  - 4. Name of Contractor.
  - 5. Name of Engineer, Architect and Construction Manager.
  - 6. RFI number, numbered sequentially.
  - 7. RFI subject.
  - 8. Specification Section number and title and related paragraphs, as appropriate.
  - 9. Drawing number and detail references, as appropriate.
  - 10. Field dimensions and conditions, as appropriate.
  - 11. Contractor's suggested resolution.
  - 12. Contractor's signature.
  - 13. Attachments: Include sketches, descriptions, measurements, photos, product data, shop drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. The following RFIs will be returned without action:
  - 1. Requests for approval of submittals.
  - 2. Requests for approval of substitutions.
  - 3. Requests for coordination information already indicated in the Contract Documents.
  - 4. Requests for adjustments in the Contract Time or the Contract Sum.
  - 5. Requests for interpretation of Architect's actions on submittals.
  - 6. Incomplete RFIs or inaccurately prepared RFIs.
- D. Action may include a request for additional information, in which case time for response will date from time of receipt of additional information.

**1.8 COORDINATION**

- A. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Utility Coordination: Contractor shall coordinate all final specific utility requirements.

**1.9 CONFLICTING REQUIREMENTS**

- A. General: If compliance with two or more standards or directives is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

**1.10 MINOR CHANGES IN THE WORK**

- A. Engineer/Architect will issue through the Construction Manager, supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.
- B. Drawings are diagrammatic, the Contractor shall relocate devices a reasonable distance for coordination.
  - 1. A reasonable distance is considered to be 15 feet at no additional cost.

**1.11 QUALITY ASSURANCE AND CONTROL**

- A. General: Qualifications paragraphs in this Article establish some of the minimum qualification levels required; Division 01 and individual Specification Sections specify additional requirements.
- B. Code Compliance: Work and equipment shall comply with all latest applicable codes and legislations.
- C. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those required for this Project.
- D. Instructor Qualifications: A factory-authorized service representative, complying with requirements in "Quality Requirements," experienced in operation and maintenance procedures and training.
- E. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

- a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  - 2. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  - 3. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- F. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.
- G. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- H. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
- 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Delivery of samples to testing agencies.
  - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- I. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
- 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- J. **Compatibility of Options:** If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
- 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
  - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used at no additional cost to the project.
- K. **Acceptance of Work:** 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 Code, Legislation, the Drawings and/or Specifications. Correct Work not in conformance whenever non-conformance is discovered.

**1.12 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions and generally accepted construction practice.
- B. **Storage:**
  - 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

### **1.13 PRODUCT WARRANTIES**

- A. Refer to Division 01 and individual sections for requirements.
- B. The following requirements are supplemental and in addition to those stated in other specific sections and Division 01.
  1. Warranty all materials and workmanship under these Specifications and the Contract for a period of one year from the date of final acceptance by the Owner.
  2. During this warranty period, correct or replace all defects developing through materials or workmanship immediately as directed by the Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction.
- C. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- D. Warranty Start Date: From the date of final acceptance by the Owner.

### **1.14 SUBMITTAL PROCEDURES**

- A. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
  1. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
- C. Substitution Requests: Submit four copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  1. Substitution: A submittal shall be considered a substitution when the Engineer/Architect does not accept the product or material as an "equivalent" or where one of the listed manufacturers is not submitted.
  2. Substitution Requirements: Substitutions shall meet the requirements of "Comparable Products."
  3. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified material or product cannot be provided.
    - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.



- c. Detailed comparison of significant qualities of proposed substitution with those of the Project scope of work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
- e. Samples, where applicable or requested.
- f. Cost information, including a proposal of change, if any, in the Contract Sum.
- g. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
- h. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- i. Statement indicating why the requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations.

D. Delegated-Design Services:

- 1. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of the Contractor by the Contract Documents, the Contractor shall provide products and systems complying with specific performance and design indicated.
  - a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to the Architect.
- 2. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to the Contractor to be designed or certified by a design professional.
  - a. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

**1.15 RECORD DRAWINGS AND RECORD DIGITAL FILES**

A. Record Drawings and Record Digital Files: Comply with the following:

- 1. Submit Record Drawings and Record Digital Files as follows:
  - a. Initial Submittal: Submit one set of plots from corrected Record CAD Drawings and one set of marked-up Record Prints. Engineer will initial and date each plot and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. Engineer will return plot for organizing into sets, printing, binding, and final submittal.
  - b. Final Submittal: Submit one sets of marked-up Record Prints.
  - c. Final Submittal: Submit three sets of Record CAD Drawing files, and one set of Record CAD Drawing plots. Plot and print each drawing, whether or not changes and additional information were recorded.
    - 1) Electronic Media: CD-R.

B. Qualification Data: For training instructor.

**1.16 PRODUCT SELECTION PROCEDURES**

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

- 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer and/or Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
6. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

**B. Product Selection Procedures:**

1. Design Basis: The design has been based on the single manufacturer indicated in the contract documents. The Contractor is responsible for verifying prior to submission, that any other manufacturer even though listed complies with dimensional and performance characteristics of the base specified product. Modifications shall be made by the Contractor as part of this contract to accommodate changes to the design basis.
2. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
3. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
4. Equivalent Product: Equipment, material or devices submitted for review as an "accepted equivalent" shall meet all of the following requirements:
  - a. A product of a listed manufacturer.
  - b. The equivalent shall have the same construction features such as, but not limited to:
    - 1) Material thickness, gauge, weight, density, etc.
    - 2) Welded, riveted, bolted, etc., construction
    - 3) Finish, undercoating, corrosion protection
  - c. The equivalent shall perform with the same or better operating efficiency.
  - d. The equivalent shall have equal or greater reserve capacity.
  - e. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  - f. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL, AMCA or ARI labels.

**1.17 PRODUCT INTEROPERABILITY REQUIREMENTS**

- A. Interoperability Coordination Meeting: Attend a minimum of 3 weekly coordination meetings to coordinate interoperability between all systems and equipment. Meetings shall be scheduled by the construction manager.
- B. General Networking and Protocol Interoperability Requirements: Provide products that are fully BACNet interoperable.
  1. All systems and equipment shall interface with the primary building management network provided under "Instrumentation and Controls for HVAC" using Ethernet standards and BACNet protocol.
  2. Equipment that is native BACNet may connect directly to a BACNet MS/TP subnet that is provided by "Instrumentation and Controls for HVAC" when coordinated with that Section Contractor.
  3. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to the most current ANSI/ASHRAE Standard 135, BACnet.
  4. The MS/TP trunks support all of the ASHRAE 135 approved baud rates.
  5. All MS/TP devices support all baud rates of the ASHRAE 135.
  6. All MS/TP devices shall be BTL approved ( BACnet Testing Lab).
  7. All BACnet routers must support B-BC (BIBB) and support BBMD routing.

8. Lonworks and Modbus subnets may be utilized where no BACNet protocol is available provided full 2-way compatibility is provided through a gateway.
    - a. Exception: Fire alarm systems shall be 1-way, read only communication.
  9. Each individual system and/or equipment manufacturer/installer shall provide all necessary gateways/translators Provide Gateway with all products as required facilitating full BACNet interoperability with BACNet Protocol.
  10. It must be possible to read and display the value of any property, including all required properties, supported optional properties, and proprietary extensions of very object of every networked device.
  11. Operating setpoints and parameters must be available for modification via BACnet services via a graphical user interface (GUI).
  12. An operator shall be able to display at any time the operational status of any device on the BACnet internetwork. An operator shall be able to display at any time any property of any BACnet object. An operator shall also be able to display property values of objects grouped by object type, object location, building system, and by user defined parameters.
  13. An operator shall have the ability to issue re-initialization commands to any device that supports remote re-initialization.
  14. An operator shall have the ability to backup and restore all BACnet devices on the network.
  15. It shall be each contractor's responsibility to configure each router using the network numbering scheme for the project. Each router shall be configured such that all network layer error messages shall be directed to a specific workstation using the BACnet Confirmed Text Message service. It shall be the contractor's responsibility to initially configure each router with routing tables containing all network numbers that are part of the project's internet. The router shall be able to receive messages at each port of any length that is valid for the LAN technology connected to that port, and to forward the message to any directly-connected network that can convey a message of that size.
  16. Legacy Systems: Bi-directional gateways shall be provided for systems and equipment operating on a legacy/proprietary system. The operator workstation shall display information from both the BACnet and non-BACnet devices. Any information specified or required for system functionality shall be made readable and modifiable. Gateways shall have 10% expansion capacity. Gateways shall support archiving, uploading, trending, scheduling, and alarm/event detection, notification and acknowledgement.
  17. Systems and equipment shall have full 2- way communications and interoperability.
    - a. Exception: Fire safety systems and equipment shall have only read access to outside systems:
      - 1) Fire alarm.
  18. Coordinate with "Instrumentation and Controls for HVAC" and other building operational systems for specific interoperability requirements.
- C. Communications Standard: Coordinate communications standards requirements with other Sections and Divisions.
1. MS/TP LAN: RS 485
  2. Systems with dedicated network(s) shall connect on the BACNet Ethernet LAN: utilizing a switch and shall meet standard Ethernet requirements.
    - a. Utilize RJ-45 terminations.
    - b. Utilize CAT 6 cabling.
    - c. Meet IEEE Standard 802.3 standards and requirements.
    - d. Speed: 100 Mbps.
  3. Equipment without dedicated networks shall connect to the BACNet MS/TP LAN.
    - a. RS 485 communications standard.
    - b. Speed: 1 Mbps.

- D. Information Availability: Make all product information, points, variables, setpoints, etc., available for access of building operational systems upon request.
  - 1. Provide bi-directional point mapping/addressing instructions.
  - 2. Provide on-site technicians as required to ensure proper information exchange.
  
- E. Factory Provided Equipment Controllers: Provide all information, points, variables, setpoints, etc., indicated and referenced in all documentation, including "Instrumentation and Controls for HVAC." Products shall have full interoperability as indicated in this Section, in BACNet standards and elsewhere.

## **PART 2 - PRODUCTS**

### **2.1 SHOP DRAWINGS**

- A. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed or electronic data.
  - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
  
  - 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

### **2.2 RECORD DRAWINGS**

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
  - 1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an understandable drawing technique.
    - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Revisions to details shown on Drawings.
    - b. Locations and depths of underground system entities.
    - c. Revisions to routing of piping.
    - d. Actual equipment locations.
    - e. Duct size and routing.
    - f. Locations of concealed internal utilities.
    - g. Changes made by Change Order or Change Directive.
    - h. Changes made following Engineer's written orders.
    - i. Details not on the original Contract Drawings.
    - j. Field records for variable and concealed conditions.
    - k. Record information on the Project scope of work that is shown only schematically.

3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  4. Mark record sets with erasable, colored pencil. Use multiple colors to distinguish between changes for different categories of the Work at same location.
  5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record CAD Drawings: Immediately before observation for Certificate of Substantial Completion, review marked-up Record Prints with Engineer and Construction Manager. When authorized, prepare a full set of corrected CAD Drawings of the Contract Drawings, as follows:
1. Format: Autodesk .dwg format of the same version, and operating system as the original Contract Drawings.
  2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
  3. Refer instances of uncertainty to Engineer for resolution.
  4. Contractor may request one set of CAD Drawings of the Contract Drawings for use in recording information.
    - a. Engineer makes no representations as to the accuracy or completeness of CAD Drawings as they relate to the Contract Drawings.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Record CAD/Revit Drawings: Organize information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each file.
  3. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Engineer, Architect and Construction Manager.
    - e. Name of Contractor.

### **2.3 RECORDING AND MAINTENANCE**

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

### **2.4 TRAINING AND INSTRUCTION PROGRAM**

- A. Program Structure: In addition to Division 01 and individual section requirements, develop an instruction program that includes individual training modules for each system and equipment not part of a system.

- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. Provide instruction for the following modules.
1. Basis of System Design and Operational Requirements
  2. Documentation
  3. Emergencies
  4. Adjustments
  5. Troubleshooting
  6. Maintenance
  7. Repairs
- C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

## **2.5 COMPARABLE PRODUCTS**

- A. Conditions for Consideration: Engineer/Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer/Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utility and system connections.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
  3. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Written Report: Where a written report listing conditions detrimental to performance of the Project scope of work is required by other Sections, include the following:
    - a. Description of the Work.
    - b. List of detrimental conditions, including substrates.
    - c. List of unacceptable installation tolerances.

- d. Recommended corrections.
- 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
- 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
- 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### **3.2 PREPARATION**

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

### **3.3 DEMOLITION**

- A. Work indicated to be removed includes removal of all auxiliary materials, accessories, anchorage, fasteners, and etc., down to bare substrate. No residual materials shall remain from work to be removed. Contractor will use whatever means necessary; including removal of all materials attached or related to those items designated to be removed, as acceptable to Owner and Engineer, to provided complete and thorough removal of existing work.
- B. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.
- D. Abandoned Work: Cut and remove buried MEP system materials, equipment, raceways, piping and distribution, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
- E. Remove demolished materials from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Field verify all existing MEP system materials, equipment, raceways, piping and distribution to be removed for exact quantities.
- H. Remove all existing MEP system materials, equipment, raceways, piping and distribution located above ceilings and in walls that are not being reused.

- I. Remove all MEP systems and appurtenances, which are to be removed, in their entireties back to the source or source panels.
- J. Remove all existing MEP system materials, equipment, raceways, piping and distribution located in walls or ceilings being demolished. Abandon no devices that have been disconnected unless specifically noted.
- K. Maintain continuity of all existing MEP devices, and utilization equipment not removed.
- L. Remove, store, protect, and reinstall existing work as required to accommodate alteration indicated.
- M. The existing work to be removed, in general, is as indicated on the Drawings and in this Section, but also includes any materials or work necessary to permit installation of new materials, as approved by Owner and Engineer.
- N. Disconnect, demolish, and remove systems, equipment, and components indicated to be removed, abandoned or as made obsolete by this project.
  - 1. To Be Removed: Remove portion of systems, equipment, and components indicated to be removed and cap or plug remaining with same or compatible material.
  - 2. To Be Abandoned in Place: Drain piping and cap or plug systems, equipment, and components with same or compatible material.
  - 3. Equipment to Be Removed: Disconnect, make safe and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect, make safe and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect, make safe and cap services and remove equipment and deliver at direction of Owner.
- O. If systems, equipment, and components to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- P. In finished areas, all systems, equipment, and components shall be cut back to a concealed location, i.e., within walls, above ceilings, etc., before capping.

### **3.4 INSTALLATION**

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
  - 4. Maintain minimum headroom clearance as indicated by Architect and/or Construction Manager in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.



- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
  
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
  - 1. All equipment and piping not supported from the building structural steel shall not exceed a combined load of 7 psf when supported from the metal deck/slab. Any condition that may exceed this limit shall be reviewed and approved by the Design-Builder and Structure Engineer before installation.
  - 2. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer and/or to allow for proper access.
  - 3. Allow for building movement, including thermal expansion and contraction.
  - 4. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
  
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

**3.5 CUTTING AND PATCHING**

- A. See Division 01 for additional requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of Work.
  
- B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the floors and walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed, where wall or floors are existing or not correctly located. The Contractor shall do all drilling required for the installation of hangers.
  
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.
  
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

**3.6 SCAFFOLDING, RIGGING, HOISTING**

- A. Excavation and backfilling shall be done per Division 2 of the Specifications.
  
- B. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

**3.7 EXCAVATION AND BACKFILLING**

- A. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division.

**3.8 ACCESSIBILITY AND ACCESS PANELS**

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the Work.

- B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Access doors shall be furnished for accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- D. Access doors in walls, ceilings, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.
- E. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- F. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.

**3.9 STARTING AND ADJUSTING**

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect field-assembled components and equipment installation, comply with qualification requirements in "Quality Requirements."

**3.10 PROTECTION OF INSTALLED CONSTRUCTION**

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.
- C. Remove debris from concealed spaces before enclosing the space.
- D. Remove liquid spills promptly.
- E. Where dust would impair proper execution of the Project scope of work, broom-clean or vacuum the entire work area, as appropriate.
- F. Installed Work: Keep installed work clean.
- G. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

**3.11 CORRECTION OF THE WORK**

- A. The cost of corrective work shall be included under the contract.
- B. Repair or remove and replace defective construction.
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- C. Restore permanent facilities used during construction to their specified or original condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components to new condition.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

**END OF SECTION 22 00 10**  
07/10/2018

**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. Rubber union connector packless expansion joints.
  - 2. Flexible-hose packless expansion joints.
  - 3. Externally pressurized metal-bellows packless expansion joints.
  - 4. Rubber packless expansion joints.
  - 5. Grooved-joint expansion joints.
  - 6. Alignment guides and anchors.
  - 7. Pipe loops and swing connections.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
  - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.
- B. Submittals shall be signed and sealed by a licensed professional engineer registered in the state where project is located.

**1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

**1.6 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

**PART 2 - PRODUCTS**

**2.1 PERFORMANCE REQUIREMENTS**

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

**2.2 PACKLESS EXPANSION JOINTS**

A. Rubber Union Connector Expansion Joints:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Amber/Booth Company, Inc.; a VMC Group Company.
  - b. Flex-Hose Co., Inc.
  - c. Flexicraft Industries.
  - d. General Rubber Corporation.
  - e. Mason Industries, Inc.
  - f. Proco Products, Inc.
  - g. Unaflex.
  - h. Unisource Manufacturing, Inc.
- 2. Material: Twin reinforced-rubber spheres with external restraining cables.
- 3. Minimum Pressure Rating: 150 psig at 170 deg F, unless otherwise indicated.
- 4. End Connections for NPS 2 and Smaller: Threaded.

B. Flexible-Hose Packless Expansion Joints:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Flex Pression Ltd.
  - b. Flex-Hose Co., Inc.
  - c. Flexicraft Industries.
  - d. Mason Industries, Inc.
  - e. Metraflex Company (The).
  - f. Unisource Manufacturing, Inc.
- 2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
- 3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
- 4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
  - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
- 5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with threaded end connections.
  - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
- 6. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.

- a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
- 7. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6: Carbon-steel fittings with flanged or welded end connections.
  - a. Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
- C. Rubber Packless Expansion Joints:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Amber/Booth Company, Inc.; a VMC Group Company.
    - b. Flex-Hose Co., Inc.
    - c. Flexicraft Industries.
    - d. Flex-Weld, Inc.
    - e. Garlock Sealing Technologies.
    - f. General Rubber Corporation.
    - g. Mason Industries, Inc.
    - h. Metraflex Company (The).
    - i. Proco Products, Inc.
    - j. Red Valve Company, Inc.
    - k. Tozen Corporation.
    - l. Unaflex.
    - m. Unisource Manufacturing, Inc.
  - 2. Standards: ASTM F 1123 and FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
  - 3. Material: Fabric-reinforced rubber complying with FSA-PSJ-703.
  - 4. Arch Type: Single or multiple arches with external control rods.
  - 5. Minimum Pressure Rating for NPS 1-1/2 to NPS 4: 150 psig at 220 deg F.
  - 6. Material for Fluids Containing Acids, Alkalis, or Chemicals: Butyl rubber, chlorosulfonyl-polyethylene rubber or ethylene-propylene-diene terpolymer rubber.
  - 7. Material for Fluids Containing Gas, Hydrocarbons, or Oil: Buna-N or chlorosulfonated polyethylene synthetic rubber.
  - 8. Material for Water: Butyl rubber, Buna-N, chlorosulfonated polyethylene synthetic rubber, chlorosulfonyl-polyethylene rubber, ethylene-propylene-diene terpolymer rubber or natural rubber.
  - 9. End Connections: Full-faced, integral steel flanges with steel retaining rings.

### **2.3 GROOVED-JOINT EXPANSION JOINTS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Anvil International.
  - 2. Shurjoint Piping Products.
  - 3. Victaulic Company.
- B. Description: Factory-assembled expansion joint made of several grooved-end pipe nipples, couplings, and grooved joints.
- C. Standard: AWWA C606, for grooved joints.
- D. Nipples: Galvanized, ASTM A 53/A 53M, Schedule 40, Type E or S, steel pipe with grooved ends.
- E. Couplings: Five, flexible type for steel-pipe dimensions. Include ferrous housing sections, Buna-N gasket suitable for diluted acid, alkaline fluids, and cold and hot water or ethylene-propylene-diene terpolymer rubber gasket suitable for cold and hot water, and bolts and nuts.

## 2.4 ALIGNMENT GUIDES AND ANCHORS

### A. Alignment Guides:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Adscoc Manufacturing LLC.
  - b. Advanced Thermal Systems, Inc.
  - c. Flex-Hose Co., Inc.
  - d. Flexicraft Industries.
  - e. Flex-Weld, Inc.
  - f. Hyspan Precision Products, Inc.
  - g. Mason Industries, Inc.
  - h. Metraflex Company (The).
  - i. Senior Flexonics Pathway.
  - j. U.S. Bellows, Inc.
  - k. Unisource Manufacturing, Inc.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

### B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
  - c. Washer and Nut: Zinc-coated steel.

## PART 3 - EXECUTION

### 3.1 EXPANSION JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."
- C. Install rubber packless expansion joints according to FSA-PSJ-703.
- D. Install grooved-joint expansion joints to grooved-end steel piping.

**3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION**

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

**3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION**

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guides on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

**3.4 EXPANSION COMPENSATION APPLICATIONS**

- A. All applications unless noted otherwise. Pipe bend and loops or flexible hose packless expansion joints.
- B. Grooved End Expansion Joints: In grooved end piping systems.
- C. Expansion Compensators: In piping systems 2-1/2 inches and smaller that are installed within enclosures where a pipe bend or loop cannot be applied. This type is not to be used in distribution mains or in systems serving critical or 24-hour operating applications.
- D. Packed Slip Expansion Joints: In piping system mains and mains serving critical or 24-hour operating applications that are installed within enclosures where a pipe bend or loop cannot be applied. Single joint up to 12 inches, double joint with intermediate anchor base for 14 inches and above.



- E. Fabric Expansion Joints: Engine exhaust applications.

**END OF SECTION 22 05 16**  
07/10/2018

**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. Sleeves.
  - 2. Stack-sleeve fittings.
  - 3. Sleeve-seal systems.
  - 4. Grout.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

**PART 2 - PRODUCTS**

**2.1 SLEEVES**

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

**2.2 STACK-SLEEVE FITTINGS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Jay R. Smith Mfg. Co.
  - 2. Zurn Industries, LLC.
  - 3. Tyler Pipe; Wade Div.
  - 4. MIFAB, Inc.
- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
  - 1. Underdeck Clamp: Clamping ring with setscrews.

**2.3 SLEEVE-SEAL SYSTEMS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
  - 4. Pipeline Seal and Insulator, Inc.

5. Proco Products, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
1. Sealing Elements: Interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
    - a. EPDM (-40 to 250 Deg. F): Standard service applications.
    - b. Nitrite (-40 to 250 Deg. F): Hydro carbon service applications.
    - c. Silicon (-67 to 400 Deg. F): High temperature or fire seal applications.
  2. Pressure Plates: Plastic. Include two for each sealing element.
    - a. Provide steel pressure plates for fire and high temperature applications.
  3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements. Include one for each sealing element.
    - a. Provide 316 stainless steel connecting bolts and nuts in corrosive environments where chemicals are present.

## **2.4 GROUT**

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## **PART 3 - EXECUTION**

### **3.1 SLEEVE INSTALLATION**

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. Sleeves shall be fastened securely to the assembly that it penetrates.
- C. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough per sleeve seal manufacturer's recommendations to provide minimum 1-inch annular clear space between piping and concrete slabs and walls.
  1. Sleeves are not required for core-drilled holes, except where mechanical spaces or wet areas are above finished floors.
- D. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
  1. Cut sleeves to length for mounting flush with both surfaces.
    - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Penetration shall be made completely watertight.
  2. Using grout, seal the space outside of sleeves in slabs and walls.

- E. Install sleeves for pipes passing through interior partitions.
  - 1. Cut sleeves to length for mounting flush with both surfaces.
  - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
  
- F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors as indicated on architectural drawings at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

### **3.2 STACK-SLEEVE-FITTING INSTALLATION**

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
  - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
  - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
  - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
  - 5. Using grout, seal the space around outside of stack-sleeve fittings.
  
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

### **3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE**

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  - 1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
    - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves.
  
  - 2. Exterior Concrete Walls below Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system or galvanized-steel-pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
  
    - b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system or galvanized-steel-pipe sleeves with sleeve-seal system.
      - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
  
  - 3. Concrete Slabs-on-Grade:
    - a. Piping Smaller Than NPS 6: Cast-iron wall sleeves with sleeve-seal system or galvanized-steel-pipe sleeves with sleeve-seal system.

- 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- b. Piping NPS 6 and Larger: Cast-iron wall sleeves with sleeve-seal system or galvanized-steel-pipe sleeves with sleeve-seal system.
  - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
- 4. Concrete Slabs above Grade:
  - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or stack-sleeve fittings.
    - 1) Provide sleeve seals where sleeves are located in floors of mechanical or wet spaces over finished spaces.
  - b. Piping NPS 6 and Larger: Galvanized-steel-pipe sleeves or stack-sleeve fittings.
    - 1) Provide sleeve seals where sleeves are located in floors of mechanical or wet spaces over finished spaces.
- 5. Interior Partitions:
  - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
  - b. Piping NPS 6 and Larger: Galvanized-steel-sheet sleeves.

**END OF SECTION 22 05 17**  
07/10/2018

**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. Escutcheons.
  - 2. Floor plates.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

**PART 2 - PRODUCTS**

**2.1 ESCUTCHEONS**

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

**2.2 FLOOR PLATES**

- A. One-Piece Floor Plates: Cast-iron flange.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type.
    - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.

- f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
  - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with rough-brass finish.
2. Escutcheons for Existing Piping:
- a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
  - b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
  - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
  - d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
  - e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
  - f. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
- 1. New Piping: One-piece, floor-plate type.
  - 2. Existing Piping: Split-casting, floor-plate type.
- 3.2 FIELD QUALITY CONTROL**
- A. Replace broken and damaged escutcheons and floor plates using new materials.

**END OF SECTION 22 05 18**  
07/10/2018

**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. Bronze angle valves.
  - 2. Bronze ball valves.
  - 3. Iron, single-flange butterfly valves.
  - 4. Bronze lift check valves.
  - 5. Bronze swing check valves.
  - 6. Bronze gate valves.
  - 7. Bronze globe valves.
  - 8. Lubricated plug valves.
  
- B. Related Sections:
  - 1. Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
  - 2. Section 221113 "Facility Water Distribution Piping" for valves applicable only to this piping.
  - 3. Section 221116 "Domestic Water Piping" for valves applicable only to this piping.
  - 4. Section 221319 "Sanitary Waste Piping Specialties" for valves applicable only to this piping.

**1.3 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of valve indicated.
  - 1. Certification that products comply with NSF 61 Annex G and NSF 372.

**1.5 QUALITY ASSURANCE**

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
  - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 2. ASME B31.1 for power piping valves.



3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G and NSF 372 for valve materials for potable-water service.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.
2. Protect threads, flange faces, grooves, and weld ends.
3. Set angle, gate, and globe valves closed to prevent rattling.
4. Set ball and plug valves open to minimize exposure of functional surfaces.
5. Set butterfly valves closed or slightly open.
6. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.
2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 8 and larger.
2. Handwheel: For valves other than quarter-turn types.
3. Handlever: For quarter-turn valves NPS 6 and smaller.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 5 plug valves, for each size square plug-valve head.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.

E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:

1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
3. Butterfly Valves: With extended neck.

F. Valve-End Connections:

1. Flanged: With flanges according to ASME B16.1 for iron valves.
2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

- G. Valve Bypass and Drain Connections: MSS SP-45.

## 2.2 BRONZE ANGLE VALVES

- A. Class 125, Bronze Angle Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Valve, Inc.
  2. Description:
    - a. Standard: MSS SP-80, Type 2.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    - d. Ends: Threaded.
    - e. Stem: Bronze.
    - f. Disc: PTFE or TFE.
    - g. Packing: Asbestos free.
    - h. Handwheel: Malleable iron, bronze, or aluminum.

## 2.3 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conbraco Industries, Inc.; Apollo Valves.
    - b. Crane Co.; Crane Valve Group; Crane Valves.
    - c. Hammond Valve.
    - d. Milwaukee Valve Company.
    - e. Red-White Valve Corporation.
    - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  2. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 150 psig.
    - c. CWP Rating: 600 psig.
    - d. Body Design: Two piece.
    - e. Body Material: Bronze.
    - f. Ends: Threaded.
    - g. Seats: PTFE or TFE.
    - h. Stem: Bronze.
    - i. Ball: Chrome-plated brass.
    - j. Port: Full.

## 2.4 IRON, SINGLE-FLANGE BUTTERFLY VALVES

- A. 200 CWP, Iron, Single-Flange Butterfly Valves with EPDM Seat and Aluminum-Bronze Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conbraco Industries, Inc.; Apollo Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. Red-White Valve Corporation.

- g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
- a. Standard: MSS SP-67, Type I.
  - b. CWP Rating: 200 psig.
  - c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
  - d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.
  - e. Seat: EPDM.
  - f. Stem: One- or two-piece stainless steel.
  - g. Disc: Aluminum bronze.

**2.5 BRONZE LIFT CHECK VALVES**

- A. Class 125, Lift Check Valves with Nonmetallic Disc:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Hammond Valve.
    - b. Milwaukee Valve Company.
    - c. Mueller Steam Specialty; a division of SPX Corporation.
    - d. Red-White Valve Corporation.
    - e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 2.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Vertical flow.
    - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
    - e. Ends: Threaded.
    - f. Disc: TFE.

**2.6 BRONZE SWING CHECK VALVES**

- A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. Red-White Valve Corporation.
    - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  - 2. Description:
    - a. Standard: MSS SP-80, Type 4.
    - b. CWP Rating: 200 psig.
    - c. Body Design: Horizontal flow.
    - d. Body Material: ASTM B 62, bronze.
    - e. Ends: Threaded.
    - f. Disc: PTFE or TFE.

## 2.7 BRONZE GATE VALVES

- A. Class 125, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  2. Description:
    - a. Standard: MSS SP-80, Type 2.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    - d. Ends: Threaded or solder joint.
    - e. Stem: Bronze.
    - f. Disc: Solid wedge; bronze.
    - g. Packing: Asbestos free.
    - h. Handwheel: Malleable iron, bronze, or aluminum.

## 2.8 BRONZE GLOBE VALVES

- A. Class 125, Bronze Globe Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Stockham Division.
    - c. Red-White Valve Corporation.
  2. Description:
    - a. Standard: MSS SP-80, Type 2.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
    - d. Ends: Threaded or solder joint.
    - e. Stem: Bronze.
    - f. Disc: PTFE or TFE.
    - g. Packing: Asbestos free.
    - h. Handwheel: Malleable iron, bronze, or aluminum.

## 2.9 IRON GLOBE VALVES

- A. Class 125, Iron Globe Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Crane Co.; Crane Valve Group; Crane Valves.
    - b. Crane Co.; Crane Valve Group; Jenkins Valves.
    - c. Crane Co.; Crane Valve Group; Stockham Division.
    - d. Hammond Valve.
    - e. Milwaukee Valve Company.
    - f. Red-White Valve Corporation.
    - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
  - a. Standard: MSS SP-85, Type I.
  - b. CWP Rating: 200 psig.
  - c. Body Material: ASTM A 126, gray iron with bolted bonnet.
  - d. Ends: Flanged.
  - e. Trim: Bronze.
  - f. Packing and Gasket: Asbestos free.

**2.10 LUBRICATED PLUG VALVES**

A. Class 125, Regular-Gland, Lubricated Plug Valves with Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Nordstrom Valves, Inc.
2. Description:
  - a. Standard: MSS SP-78, Type II.
  - b. CWP Rating: 200 psig.
  - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
  - d. Pattern: Regular or short.
  - e. Plug: Cast iron or bronze with sealant groove.

B. Class 125, Regular-Gland, Lubricated Plug Valves with Flanged Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Nordstrom Valves, Inc.
2. Description:
  - a. Standard: MSS SP-78, Type II.
  - b. CWP Rating: 200 psig.
  - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
  - d. Pattern: Regular or short.
  - e. Plug: Cast iron or bronze with sealant groove.

C. Class 125, Cylindrical, Lubricated Plug Valves with Threaded Ends:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Homestead Valve; a division of Olson Technologies, Inc.
  - b. Milliken Valve Company.
  - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
2. Description:
  - a. Standard: MSS SP-78, Type IV.
  - b. CWP Rating: 200 psig.
  - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
  - d. Pattern: Regular or short.
  - e. Plug: Cast iron or bronze with sealant groove.

- D. Class 125, Cylindrical, Lubricated Plug Valves with Flanged Ends:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Homestead Valve; a division of Olson Technologies, Inc.
    - b. Milliken Valve Company.
    - c. R & M Energy Systems; a unit of Robbins & Myers, Inc.
  2. Description:
    - a. Standard: MSS SP-78, Type IV.
    - b. CWP Rating: 200 psig.
    - c. Body Material: ASTM A 48/A 48M or ASTM A 126, cast iron with lubrication-sealing system.
    - d. Pattern: Regular or short.
    - e. Plug: Cast iron or bronze with sealant groove.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

#### **3.2 VALVE INSTALLATION**

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
  1. Swing Check Valves: In horizontal position with hinge pin level.
  2. Center-Guided Check Valves: In horizontal or vertical position, between flanges.
  3. Lift Check Valves: With stem upright and plumb.

#### **3.3 ADJUSTING**

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

### 3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
1. Shutoff Service: Ball, butterfly, gate, or plug valves.
  2. Butterfly Valve Dead-End Service: Single-flange (lug) type.
  3. Throttling Service: Globe or angle or butterfly valves.
  4. Pump-Discharge Check Valves:
    - a. NPS 2 and Smaller: Bronze swing check valves with nonmetallic disc.
    - b. NPS 2-1/2 and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.
    - c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
  2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.
  3. For Copper Tubing, NPS 5 and Larger: Flanged ends.
  4. For Steel Piping, NPS 2 and Smaller: Threaded ends.
  5. For Steel Piping, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

### 3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
  2. Bronze Angle Valves: Class 125, nonmetallic disc.
  3. Ball Valves: Two piece, full port, bronze with bronze trim.
  4. Bronze Swing Check Valves: Class 125, nonmetallic disc.
  5. Bronze Gate Valves: Class 125, RS.
  6. Bronze Globe Valves: Class 125, nonmetallic disc.
- B. Pipe NPS 2-1/2 and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.
  2. Iron, Single-Flange Butterfly Valves: 200 CWP, EPDM seat, aluminum-bronze disc.
  3. Iron Swing Check Valves: Class 125, nonmetallic-to-metal seats.
  4. Iron Swing Check Valves with Closure Control: Class 125, lever and spring or weight.
  5. Iron, Center-Guided Check Valves: Class 125, compact-wafer, resilient seat.
  6. Iron Gate Valves: Class 125, OS&Y.
  7. Iron Globe Valves: Class 125.

END OF SECTION 22 05 23  
07/10/2018

**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. Metal pipe hangers and supports.
  - 2. Trapeze pipe hangers.
  - 3. Metal framing systems.
  - 4. Thermal-hanger shield inserts.
  - 5. Fastener systems.
  - 6. Pipe stands.
  - 7. Pipe positioning systems.
  - 8. Equipment supports.
  
- B. Related Sections:
  - 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
  - 2. Section 220516 "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.

**1.3 DEFINITIONS**

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
  
- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.
  - 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
  - 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
  - 3. Design seismic-restraint hangers and supports for piping and equipment.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
  
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
  - 1. Trapeze pipe hangers.
  - 2. Metal framing systems.
  - 3. Pipe stands.
  - 4. Equipment supports.



- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Detail fabrication and assembly of trapeze hangers.
  - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.

**1.7 QUALITY ASSURANCE**

- A. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS**

- A. Comply with requirements in Part 3 articles for where materials shall be applied.

**2.2 METAL PIPE HANGERS AND SUPPORTS**

- A. Carbon-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
  - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
  - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
- B. Stainless-Steel Pipe Hangers and Supports:
  - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
  - 2. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
  - 3. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel.
- C. Copper Pipe Hangers:
  - 1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
  - 2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel or stainless steel.

**2.3 TRAPEZE PIPE HANGERS**

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

**2.4 METAL FRAMING SYSTEMS**

- A. MFMA Manufacturer Metal Framing Systems:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit; a part of Atkore International.

- b. B-line, an Eaton business.
  - c. Flex-Strut Inc.
  - d. Thomas & Betts Corporation; A Member of the ABB Group.
  - e. Unistrut; Part of Atkore International.
  - f. Wesanco, Inc.
- 2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
  - 3. Standard: MFMA-4.
  - 4. Channels: Continuous slotted steel channel with inturned lips.
  - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel or stainless steel.
  - 7. Metallic Coating: Electroplated zinc, hot-dipped galvanized, mill galvanized, in-line, hot galvanized, or mechanically-deposited zinc.
  - 8. Paint Coating: Vinyl, vinyl alkyd, epoxy, polyester, acrylic, amine, or alkyd.
  - 9. Plastic Coating: PVC, polyurethane, epoxy, or polyester.
- B. Non-MFMA Manufacturer Metal Framing Systems:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Anvil International.
    - b. Empire Industries, Inc.
    - c. ERICO International Corporation.
    - d. Haydon Corporation.
    - e. NIBCO INC.
    - f. PHD Manufacturing, Inc.
    - g. PHS Industries, Inc.
  - 2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
  - 3. Standard: Comply with MFMA-4.
  - 4. Channels: Continuous slotted steel channel with inturned lips.
  - 5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
  - 6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel, or stainless steel.
  - 7. Coating: Zinc, paint or PVC.

## **2.5 THERMAL-HANGER SHIELD INSERTS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Carpenter & Paterson, Inc.
  - 2. Clement Support Services.
  - 3. ERICO International Corporation.
  - 4. National Pipe Hanger Corporation.
  - 5. PHS Industries, Inc.
  - 6. Pipe Shields Inc.
  - 7. Piping Technology & Products, Inc.
  - 8. Rilco Manufacturing Co., Inc.
  - 9. Value Engineered Products, Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

## **2.6 FASTENER SYSTEMS**

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Verify suitability use in lightweight concrete slabs and all slabs less than 4 inches thick.
- B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Verify suitability use in lightweight concrete slabs and all slabs less than 4 inches thick.

## **2.7 PIPE STANDS**

- A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.
- B. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

## **2.8 PIPE POSITIONING SYSTEMS**

- A. Description: IAPMO PS 42, positioning system of metal brackets, clips, and straps for positioning piping in pipe spaces; for plumbing fixtures in commercial applications.

## **2.9 EQUIPMENT SUPPORTS**

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

## **2.10 MISCELLANEOUS MATERIALS**

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
  - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
  - 2. Design Mix: 5000-psi, 28-day compressive strength.

## **PART 3 - EXECUTION**

### **3.1 HANGER AND SUPPORT INSTALLATION**

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
  - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Fiberglass Strut System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled fiberglass struts.
- E. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping as indicated herein.
- F. Fastener System Installation:
  1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
  3. Verify suitability of fasteners in lightweight concrete slabs less than 4 inches thick.
- G. Pipe Stand Installation:
  1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
  2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Section 077200 "Roof Accessories" for curbs. Seismically restrain assembly to structure.
- H. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture.
- I. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- J. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- K. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- L. Install lateral bracing with pipe hangers and supports to prevent swaying.
- M. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- N. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- O. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- P. Insulated Piping:
  1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

- b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
- c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
- 2. Install MSS SP-58, Type 39, galvanized protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 3. Install MSS SP-58, Type 40, galvanized protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees or per thermal hanger insert manufacturer recommendations.
  - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
- 4. Shield Dimensions for Pipe: Not less than the following or per thermal hanger insert manufacturer recommendations:
  - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - b. NPS 4: 12 inches long and 0.06 inch thick.
- 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### **3.2 EQUIPMENT SUPPORTS**

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

### **3.3 METAL FABRICATIONS**

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

### **3.4 ADJUSTING**

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

**3.5 PAINTING**

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**3.6 HANGER AND SUPPORT SCHEDULE**

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with hot-dipped galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and fiberglass pipe hangers and fiberglass strut systems and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
  - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
  12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
  13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
  14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
  15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
  16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
  17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
  18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
  19. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
  20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
  21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
  2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
  6. C-Clamps (MSS Type 23): For structural shapes.
  7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
    - a. Light (MSS Type 31): 750 lb.
    - b. Medium (MSS Type 32): 1500 lb.
    - c. Heavy (MSS Type 33): 3000 lb.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
  14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- M. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): For supporting insulated pipe without vapor barrier, fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe with vapor barrier.
- N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections. Provide per Divisions 21, 22 and 23 mechanical vibration and seismic control sections.
- O. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- P. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- Q. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction. Verify suitability use in lightweight concrete slabs and all slabs less than 4 inches thick.
- R. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

**END OF SECTION 22 05 29**  
07/10/2018



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**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. Equipment labels.
  - 2. Warning signs and labels.
  - 3. Pipe labels.
  - 4. Stencils.
  - 5. Valve tags.
  - 6. Warning tags.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label. Furnish extra copies, in addition to mounted copies, for inclusion in maintenance manuals. Provide one copy on electronic media, type specified by Owner.
- D. Valve numbering scheme.
- E. Valve Schedules: Provide separate schedule for each piping system to include in maintenance manuals. Provide one copy on electronic media, type specified by Owner.

**1.4 QUALITY ASSURANCE**

- A. Massachusetts Board of Registration of Plumbers and Gas Fitters Approval: Products shall be listed in the Accepted Plumbing Products System and indicate approval on product submittal.

**1.5 COORDINATION**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Coordinate names, abbreviations, and other designations used in mechanical identification with Owner's desired identification scheme, regardless of numbering indicated on the drawings and specifications. Coordinate Owner's desired identification scheme with ASME and OSHA standards.
- E. Coordinate with Architect, locations of all identifying devices in public view areas.

**PART 2 - PRODUCTS**

**2.1 EQUIPMENT LABELS**

A. Metal Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.
  - f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.
  - i. Marking Services, Inc.
  - j. Seton Identification Products.
2. Material and Thickness: Stainless steel, 0.025-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
3. Letter Color: White.
4. Background Color: Blue.
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
7. Fasteners: Stainless-steel self-tapping screws.
8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Plastic Labels for Equipment:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Brady Corporation.
  - b. Brimar Industries, Inc.
  - c. Carlton Industries, LP.
  - d. Champion America.
  - e. Craftmark Pipe Markers.
  - f. emedco.
  - g. Kolbi Pipe Marker Co.
  - h. LEM Products Inc.
  - i. Marking Services, Inc.
  - j. Seton Identification Products.
2. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
3. Letter Color: Black.
4. Background Color: White.
5. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
6. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
7. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
8. Fasteners: Stainless-steel self-tapping screws.
9. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

- C. Label Content: Include equipment's Drawing designation and Owner-specified unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- D. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

## **2.2 WARNING SIGNS AND LABELS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Brady Corporation.
  - 2. Brimar Industries, Inc.
  - 3. Carlton Industries, LP.
  - 4. Champion America.
  - 5. Craftmark Pipe Markers.
  - 6. emedco.
  - 7. LEM Products Inc.
  - 8. Marking Services Inc.
  - 9. National Marker Company.
  - 10. Seton Identification Products.
  - 11. Stranco, Inc.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Black.
- D. Background Color: White.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- H. Fasteners: Stainless-steel self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

## **2.3 PIPE LABELS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following. Color shall comply with ASME A13.1 unless otherwise noted.
  - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  - 2. Brady Corporation.
  - 3. Brimar Industries, Inc.
  - 4. Carlton Industries, LP.
  - 5. Champion America.
  - 6. Craftmark Pipe Markers.
  - 7. emedco.
  - 8. Kolbi Pipe Marker Co.

9. LEM Products Inc.
  10. Marking Services Inc.
  11. Seton Identification Products.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing. Label material shall be rated for use in air plenum spaces.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
  2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.

## **2.4 STENCILS**

- A. Stencils for Piping:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Brimar Industries, Inc.
    - b. Carlton Industries, LP.
    - c. Champion America.
    - d. Craftmark Pipe Markers.
    - e. Kolbi Pipe Marker Co.
    - f. Marking Services Inc.
  2. Lettering Size: At least 1/2 inch for viewing distances up to 72 inches and proportionately larger lettering for greater viewing distances.
  3. Stencil Material: Fiberboard or metal.
  4. Stencil Paint: Exterior, gloss, acrylic enamel in colors complying with recommendations in ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.
  5. Identification Paint: Exterior, acrylic enamel in colors according to ASME A13.1 unless otherwise indicated. Paint may be in pressurized spray-can form.

## **2.5 VALVE TAGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
  2. Brady Corporation.
  3. Brimar Industries, Inc.
  4. Carlton Industries, LP.
  5. Champion America.
  6. Craftmark Pipe Markers.
  7. emedco.
  8. Kolbi Pipe Marker Co.
  9. LEM Products Inc.
  10. Marking Services Inc.
  11. Seton Identification Products.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Owner.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  2. Fasteners: Brass beaded chain.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.
- D. Schedule on Electronic Media:
1. In addition to the framed paper schedule, provide valve schedule on electronic media, type specified by Owner, and identified points on as-built drawings.

## 2.6 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
  2. Brimar Industries, Inc.
  3. Carlton Industries, LP.
  4. Champion America.
  5. Craftmark Pipe Markers.
  6. emedco.
  7. Kolbi Pipe Marker Co.
  8. LEM Products Inc.
  9. Marking Services Inc.
  10. Seton Identification Products.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: Approximately 4 by 7 inches.
  2. Fasteners: Brass grommet and wire.
  3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
  4. Color: Safety yellow background with black lettering.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

### 3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Label Content: Provide the following equipment information on labels:
1. Equipment drawing designation and Owner-specified unique equipment identification number.

2. Drawing numbers where equipment is located or specified (floor plans and schedules).
3. Specification section equipment is specified.
4. Manufacturer, model name and number, serial number(s).
5. Labels of equipment listings by testing agencies (e.g., UL listings).

### **3.3 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

### **3.4 PIPE LABEL INSTALLATION**

- A. Manufacturer Pipe Labels: Provide on all piping except piping in return air plenums.
- B. Stenciled Pipe Label Option: Stenciled labels shall be provided instead of manufactured pipe labels, for piping located in return air plenums. Install stenciled pipe labels, complying with ASME A13.1, with painted, color-coded bands or rectangles on each piping system.
  1. Identification Paint: Use for contrasting background.
  2. Stencil Paint: Use for pipe marking.
- C. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
  1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
  4. At access doors, manholes, and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
  7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- D. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- E. Pipe Label Color Schedule:
  1. Domestic Water Piping
    - a. Background: Safety green.
    - b. Letter Colors: White.
  2. Sanitary Waste, Vent and Storm Drainage Piping:
    - a. Background Color: Safety green.
    - b. Letter Color: White.

### **3.5 VALVE-TAG INSTALLATION**

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:

- a. Cold Water: 1-1/2 inches.
- b. Hot Water: 1-1/2 inches.

**3.6 WARNING-TAG INSTALLATION**

A. Write required message on, and attach warning tags to, equipment and other items where required.

**END OF SECTION 22 05 53**  
07/10/2018



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**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 insulating the following plumbing piping services:
  - 1. Domestic cold-water piping.
  - 2. Domestic hot-water piping.
  - 3. Domestic recirculating hot-water piping.
  - 4. Supplies and drains for handicap-accessible lavatories and sinks.
- B. Related Sections:
  - 1. Section 220716 "Plumbing Equipment Insulation."

**1.3 DEFINITIONS**

- A. ASJ: All-service jacket.
- B. Conditioned Space: An area, room, ceiling, space/plenum or space within the building structure being heated or cooled (by direct expansion or chilled water) or both, by directly or indirectly, by equipment or appliance, and is not subject to outdoor ambient conditions.
- C. Unconditioned Space: An area, room or space within the building structure not being conditioned and subject to outdoor ambient conditions.
- D. Concealed Pipes: Piping not visible within the room it is located, after the project is completed.
- E. Exposed Pipes: Piping visible within the room it is located, after the project is completed.
- F. Ceiling Space/Plenum: An enclosed portion of the building structure, other than an occupiable space being conditioned, that is designed to allow air movement, and thereby serve as part of an air distribution system.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.
- C. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Mockup may be built as part of the installed system. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.
  - 1. Piping Mockups:
    - a. One 10-foot section of NPS 2 straight pipe.
    - b. One each of a 90-degree threaded, welded, and flanged elbow.
    - c. One each of a threaded, welded, and flanged tee fitting.
    - d. One NPS 2 or smaller valve, and one NPS 2-1/2 or larger valve.
    - e. Four support hangers including hanger shield and insert.
    - f. One threaded strainer and one flanged strainer with removable portion of insulation.
    - g. One threaded reducer and one welded reducer.
    - h. One pressure temperature tap.
    - i. One mechanical coupling.
  - 2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
  - 3. Notify Architect seven days in advance of dates and times when mockups will be constructed.
  - 4. Obtain Architect's approval of mockups before starting insulation application.
  - 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
  - 6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 7. Demolish and remove mockups when directed.
- D. Comply with the following applicable standards and other requirements specified for miscellaneous components:
  - 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

**1.8 COORDINATION**

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

**1.9 SCHEDULING**

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS**

- A. Comply with requirements in Part 3 articles for where materials shall be applied.

**2.2 INSULATION MATERIALS**

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Lock; K-Fit Elbow, Tee, and P-Trap; K-FLEX LS.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; a Berkshire Hathaway company; Microlite.
    - b. Knauf Insulation; Atmosphere Duct Wrap with ECOSE Technology.

c. Owens Corning; SOFTR All-Service Duct Wrap.

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Johns Manville; a Berkshire Hathaway company; Micro-Lok.
  - b. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation with ECOSE Technology; Earthwool Redi-Klad 1000 Degree Pipe Insulation with ECOSE Technology.
  - c. Owens Corning; Fiberglas Pipe Insulation or SSL II.
2. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with a minimum density of 3.5 pcf, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

### 2.3 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Foster Brand; H. B. Fuller Construction Products; 30-80/30-90.
  - b. Knauf Insulation; EXPERT Mastics - KI-900 ASJ; EXPERT Mastics - KI-905 ASJ+.
  - c. Vimasco Corporation.
2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products; CP-10.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products; 46-50.
  - d. Knauf Insulation; EXPERT Mastics - KI-700 ASJ; EXPERT Mastics - KI-705 ASJ+.
  - e. Mon-Eco Industries, Inc.; 55-50.
  - f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

### 2.4 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products; CP-76.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products; 95-44.
  - d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

**B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:**

1. Products: Subject to compliance with requirements, provide the following:
  - a. Childers Brand; H. B. Fuller Construction Products; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

**2.5 FACTORY-APPLIED JACKETS**

**A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:**

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

**2.6 FIELD-APPLIED JACKETS**

**A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.**

**B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; 25/50 flame-spread / smoke developed rating; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.**

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Johns Manville; a Berkshire Hathaway company; Zeston.
  - b. P.I.C. Plastics, Inc.; FG Series.
  - c. Proto Corporation; LoSmoke.
  - d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.
4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
  - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

**C. Metal Jacket:**

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products; Metal Jacketing Systems.
  - b. ITW Insulation Systems; Illinois Tool Works, Inc.; Aluminum and Stainless Steel Jacketing.
  - c. RPR Products, Inc.; Insul-Mate.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Factory cut and rolled to required size.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
  - e. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
  - a. Factory cut and rolled to required size.
  - b. Material, finish, and thickness are indicated in field-applied jacket schedules.

## **2.7 TAPES**

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - b. Compac Corporation; 104 and 105.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
    - d. Knauf Insulation; EXPERT Tapes - ASJ Tape; EXPERT Tapes - ASJ+ Tape.
    - e. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corporation; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    - d. Knauf Insulation; EXPERT Tapes - FSK Tape.
    - e. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.

7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Compac Corporation.
    - b. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    - c. Venture Tape; 1506 CW NS.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - d. Knauf Insulation; EXPERT Tapes - 2 Mil Foil Tape.
    - e. Venture Tape; 3520 CW.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.

## **2.8 SECUREMENTS**

- A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.; Gerrard Strapping and Seals.
    - b. RPR Products, Inc.; Insul-Mate Strapping and Seals.
  2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 3/4 inch wide with wing seal or closed seal.
  3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch- wide, stainless steel or Monel.

## **2.9 PROTECTIVE SHIELDING GUARDS**

- A. Protective Shielding Pipe Covers:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Engineered Brass Company.
    - b. Insul-Tect Products Co..
    - c. McGuire Manufacturing.
    - d. Plumberex Specialty Products, Inc.



- e. Truebro.
  - f. Zurn Industries, LLC.
  - 2. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
  - 3. Product must comply with ASTM E84 for flame-spread and smoke developed requirements for Class A materials.
- B. Protective Shielding Piping Enclosures:
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Truebro.
    - b. Zurn Industries, LLC.
  - 2. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 PREPARATION**

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

#### **3.3 GENERAL INSTALLATION REQUIREMENTS**

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.

- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - a. For below-ambient services, apply vapor-barrier mastic over staples.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Cleanouts.

### **3.4 PENETRATIONS**

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistant joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
  2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

### **3.5 GENERAL PIPE INSULATION INSTALLATION**

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### **3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION**

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- B. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### **3.7 INSTALLATION OF MINERAL-FIBER INSULATION**

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

**B. Insulation Installation on Pipe Flanges:**

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

**C. Insulation Installation on Pipe Fittings and Elbows:**

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

**D. Insulation Installation on Valves and Pipe Specialties:**

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

**3.8 FIELD-APPLIED JACKET INSTALLATION**

**A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.**

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

**B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.**

1. Apply jacket directly over bare insulation or insulation with factory applied jackets. Stagger seams of insulation.
  - a. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  - b. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
  - c. Angles, channels, or other members shall be aluminum.
  - d. Fasteners shall be aluminum or stainless steel.
  - e. Fabricate jacket so top is center supported with high point and pitches to prevent ponding of water on top of duct and fittings.
  - f. Caulk jacket seams and joints with suitable weather- and sun-resistant sealant. Apply 6-inch wide "Peel & Seal" self-stick aluminum roll roofing over all caulked seams, joints, supports, and penetrations of jacket.

**3.9 FINISHES**

**A. Insulation with ASJ or Other Paintable Jacket Material for Exposed Piping in Finished Spaces: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."**

1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
  - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

**3.10 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

**3.11 PIPING INSULATION SCHEDULE, GENERAL**

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  1. Underground piping.
  2. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

**3.12 INDOOR PIPING INSULATION SCHEDULE**

- A. Domestic Cold Water:
  1. NPS 1 and Smaller: Insulation shall be the following:
    - a. Flexible Elastomeric: 1 inch thick for indoor belowground piping only.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
  2. NPS 1-1/4 and Larger: Insulation shall be the following:
    - a. Flexible Elastomeric: 1 inch thick for indoor belowground piping only.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inch thick.
- B. Domestic Hot, Tempered and Recirculated Hot Water:
  1. NPS 1-1/4 and Smaller: Insulation shall be the following:
    - a. Flexible Elastomeric: 1 inch thick for indoor belowground piping only.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick for 140 deg. F and below; 1-1/2 inches thick for above 140 deg. F.
  2. NPS 1-1/2 and Larger: Insulation shall be the following:
    - a. Flexible Elastomeric: 1 inch thick for belowground piping only.
    - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick.

- C. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Pre-formed Vinyl: 1/8 inch thick.
  
- D. Sanitary Waste and Storm Piping Where Heat Tracing Is Installed:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches thick installed over heat tracing for aboveground piping.
    - b. Flexible Elastomeric: 1 inch thick, installed over heat tracing for indoor belowground piping only.
  
- E. Condensate and Equipment Drain Water Below 60 Deg. F:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Mineral-Fiber, Preformed Pipe Insulation, Type 1, 1 inch thick.
  
- F. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:
  - 1. All Pipe Sizes: Insulation shall be the following:
    - a. Flexible Elastomeric: 1 inch thick.

**3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
  - 1. None.
- D. Piping, Exposed:
  - 1. None, except in food handling areas
  - 2. Stainless steel in food handling areas with sealed joints.

**END OF SECTION 22 07 19**  
07/10/2018

**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. Under-building-slab and aboveground domestic water pipes, tubes, and fittings inside buildings.
  - 2. Encasement for piping.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For transition fittings and dielectric fittings.

**1.4 INFORMATIONAL SUBMITTALS**

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

**1.5 FIELD CONDITIONS**

- A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of water service.
  - 2. Do not interrupt water service without Owner's written permission.

**1.6 QUALITY ASSURANCE**

- A. References:
  - 1. ASTM International (ASTM):
    - a. ASTM D 2765 - Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics.
    - b. ASTM D 6394 - Specification for Sulfone Plastics (SP).
    - c. ASTM E 84 - Standard Test Method for Surface Burning Characteristics of Building Materials.
    - d. ASTM E 119 - Standard Test Methods for Fire Tests of Building Construction and Materials.
    - e. ASTM E 814 - Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
    - f. ASTM F 876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
    - g. ASTM F 877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.
    - h. ASTM F 1960 - Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) Tubing.
  - 2. American Water Works Association:
    - a. AWWA C904 Standard for Crosslinked Polyethylene (PEX) Pressure Pipe, 1/2-Inch Through 3-Inch, for Water Service.



3. American National Standards Institute (ANSI) / National Sanitation Foundation (NSF):
  - a. ANSI/NSF Standard 14 Plastics Piping System Components and Related Materials.
  - b. ANSI/NSF Standard 61 Drinking Water System Components - Health Effects.
4. American National Standards Institute (ANSI)/Underwriters Laboratories, Inc. (UL):
  - a. ANSI/UL 263 Standard for Safety for Fire Tests of Building Construction and Materials.
  - b. ANSI/UL 2846 Standard for Fire Test of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.
5. American Society of Mechanical Engineers (ASME):
  - a. ASME B 16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
6. International Code Council (ICC):
  - a. International Plumbing Code (IPC).
7. International Association of Plumbing Officials (IAPMO):
  - a. Uniform Plumbing Code (UPC).
8. Plastics Pipe Institute (PPI):
  - a. PPI Technical Report TR-4/06.
9. Underwriters Laboratories (UL):
  - a. UL 2846 Standard for Fire Tests of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.

## **PART 2 - PRODUCTS**

### **2.1 PIPING MATERIALS**

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61 Annex G. Plastic piping components shall be marked with "NSF-pw."

### **2.2 COPPER TUBE AND FITTINGS**

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Cast-Copper, Solder-Joint Fittings: ASME B16.18, pressure fittings.
- C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
- D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- E. Copper Unions:
  1. MSS SP-123.
  2. Cast-copper-alloy, hexagonal-stock body.
  3. Ball-and-socket, metal-to-metal seating surfaces.

4. Solder-joint or threaded ends.

F. Copper Pressure-Seal-Joint Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Elkhart Products Corporation.
  - b. NIBCO INC.
  - c. Viega LLC.
2. Fittings for NPS 2 and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
3. Fittings for NPS 2-1/2 to NPS 4: Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

**2.3 PIPING JOINING MATERIALS**

A. Pipe-Flange Gasket Materials:

1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
2. Full-face or ring type unless otherwise indicated.

B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

C. Solder Filler Metals: ASTM B 32, lead-free alloys.

D. Flux: ASTM B 813, water flushable.

**2.4 ENCASEMENT FOR PIPING**

A. Standard: ASTM A 674 or AWWA C105/A21.5.

B. Form: Sheet or tube.

C. Color: Black or natural.

**2.5 TRANSITION FITTINGS**

A. General Requirements:

1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cascade Waterworks Mfg. Co.
  - b. Dresser, Inc.
  - c. Ford Meter Box Company, Inc. (The).
  - d. Jay R. Smith Mfg. Co.
  - e. JCM Industries, Inc.
  - f. Romac Industries, Inc.
  - g. Smith-Blair, Inc.
  - h. Viking Johnson.

D. Plastic-to-Metal Transition Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Charlotte Pipe and Foundry Company.
  - b. Harvel Plastics, Inc.
  - c. Spears Manufacturing Company.
  - d. Uponor.
2. Description:
  - a. CPVC or PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions.
  - b. One end with threaded brass insert and one solvent-cement-socket or threaded end.

**2.6 DIELECTRIC FITTINGS**

A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. A.Y. McDonald Mfg. Co.
  - b. Capitol Manufacturing Company.
  - c. Central Plastics Company.
  - d. HART Industrial Unions, LLC.
  - e. Jomar Valve.
  - f. Matco-Norca.
  - g. Watts; a Watts Water Technologies company.
  - h. Wilkins.
  - i. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Pressure Rating: 150 psig.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Capitol Manufacturing Company.
  - b. Central Plastics Company.
  - c. Matco-Norca.
  - d. Watts; a Watts Water Technologies company.
  - e. Wilkins.
  - f. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 150 psig.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Products & Systems, Inc.

- b. Calpico, Inc.
    - c. Central Plastics Company.
    - d. Pipeline Seal and Insulator, Inc.
  - 2. Nonconducting materials for field assembly of companion flanges.
  - 3. Pressure Rating: 150 psig.
  - 4. Gasket: Neoprene or phenolic.
  - 5. Bolt Sleeves: Phenolic or polyethylene.
  - 6. Washers: Phenolic with steel backing washers.
- E. Dielectric Nipples:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Elster Perfection Corporation.
    - b. Grinnell Mechanical Products.
    - c. Matco-Norca.
    - d. Precision Plumbing Products.
    - e. Victaulic Company.
  - 2. Standard: IAPMO PS 66.
  - 3. Electroplated steel nipple complying with ASTM F 1545.
  - 4. Pressure Rating and Temperature: 300 psig at 225 deg F.
  - 5. End Connections: Male threaded or grooved.
  - 6. Lining: Inert and noncorrosive, propylene.

### **PART 3 - EXECUTION**

#### **3.1 EARTHWORK**

- A. Comply with requirements in Section 312000 "Earth Moving" for excavating, trenching, and backfilling.

#### **3.2 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install copper tubing under building slab according to CDA's "Copper Tube Handbook."
- C. Install underground copper tube in PE encasement according to ASTM A 674 or AWWA C105/A21.5.
- D. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- E. Install shutoff valve immediately upstream of each dielectric fitting.
- F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements for pressure-reducing valves in Section 221119 "Domestic Water Piping Specialties."
- G. Install domestic water piping level without pitch and plumb.
- H. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- I. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- J. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- K. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- L. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- M. Install piping to permit valve servicing.
- N. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- O. Install piping free of sags and bends.
- P. Install fittings for changes in direction and branch connections.
- Q. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- R. Install pressure gages on suction and discharge piping for each plumbing pump and packaged booster pump. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping."
- S. Install thermostats in hot-water circulation piping. Comply with requirements for thermostats in Section 221123 "Domestic Water Pumps."
- T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### **3.3 JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

- F. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

### **3.4 TRANSITION FITTING INSTALLATION**

- A. Install transition couplings at joints of dissimilar piping.
- B. Transition Fittings in Underground Domestic Water Piping:
  - 1. Fittings for NPS 1-1/2 and Smaller: Fitting-type coupling.
  - 2. Fittings for NPS 2 and Larger: Sleeve-type coupling.
- C. Transition Fittings in Aboveground Domestic Water Piping NPS 2 and Smaller: Plastic-to-metal transition fittings.

### **3.5 DIELECTRIC FITTING INSTALLATION**

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

### **3.6 HANGER AND SUPPORT INSTALLATION**

- A. Comply with requirements for seismic-restraint devices in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
  - 1. Vertical Piping: MSS Type 8 or 42, clamps.
  - 2. Individual, Straight, Horizontal Piping Runs:
    - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    - b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
    - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
  - 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
  - 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
  - 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
  - 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
  - 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
  - 4. NPS 2-1/2: 108 inches with 1/2-inch rod.

- 5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.
- F. Install supports for vertical copper tubing every 10 feet.
- G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

### **3.7 CONNECTIONS**

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.
- C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.
- D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
  - 1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
  - 2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.
  - 3. Equipment: Cold- and hot-water-supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 and larger.

### **3.8 IDENTIFICATION**

- A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."
- B. Label pressure piping with system operating pressure.

### **3.9 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Piping Inspections:
    - a. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
    - b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
      - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
    - c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
    - d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
  - 2. Piping Tests:
    - a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

- b. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
- c. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

### **3.10 ADJUSTING**

A. Perform the following adjustments before operation:

- 1. Close drain valves, hydrants, and hose bibbs.
- 2. Open shutoff valves to fully open position.
- 3. Open throttling valves to proper setting.
- 4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
  - a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide hot-water flow in each branch.
  - b. Adjust calibrated balancing valves to flows indicated.
- 5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
- 6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
- 7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
- 8. Check plumbing specialties and verify proper settings, adjustments, and operation.

### **3.11 CLEANING**

A. Clean and disinfect potable domestic water piping as follows:

- 1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
- 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
  - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
  - b. Fill and isolate system according to either of the following:
    - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
    - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.
  - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
  - d. Repeat procedures if biological examination shows contamination.
  - e. Submit water samples in sterile bottles to authorities having jurisdiction.



- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

**3.12 PIPING SCHEDULE**

- A. Transition and special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:
  - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
  - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.
- E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be one of the following:
  - 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
  - 2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

**3.13 VALVE SCHEDULE**

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
  - 1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
  - 2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
  - 3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
  - 4. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

**END OF SECTION 22 11 16**  
07/10/2018

**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. Vacuum breakers.
  - 2. Backflow preventers.
  - 3. Water pressure-reducing valves.
  - 4. Balancing valves.
  - 5. Temperature-actuated, water mixing valves.
  - 6. Strainers.
  - 7. Outlet boxes.
  - 8. Hose bibbs.
  - 9. Wall hydrants.
  - 10. Drain valves.
  - 11. Water-hammer arresters.
  - 12. Air vents.
  - 13. Trap-seal primer valves.
  - 14. Trap-seal primer systems.
- B. Related Requirements:
  - 1. Section 221116 "Domestic Water Piping" for water meters.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: For domestic water piping specialties.
  - 1. Include diagrams for power, signal, and control wiring.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES**

- A. Potable-water piping and components shall comply with NSF 61 Annex G and NSF 14. Mark "NSF-pw" on plastic piping components.

**2.2 PERFORMANCE REQUIREMENTS**

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

**2.3 VACUUM BREAKERS**

A. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Cash Acme.
  - b. Conbraco Industries, Inc.
  - c. MIFAB, Inc.
  - d. Watts; a Watts Water Technologies company.
  - e. Woodford Manufacturing Company.
  - f. Zurn Industries, LLC.
2. Standard: ASSE 1011.

B. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Co.
  - b. Conbraco Industries, Inc.
  - c. FEBCO.
  - d. Watts; a Watts Water Technologies company.
  - e. Zurn Industries, LLC.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig maximum, through middle third of flow range.
5. Accessories:
  - a. Valves: Ball type, on inlet and outlet.

**2.4 BACKFLOW PREVENTERS**

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Co.
  - b. Conbraco Industries, Inc.
  - c. FEBCO.
  - d. Watts; a Watts Water Technologies company.
  - e. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Accessories:
  - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
  - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
  - c. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Double-Check, Backflow-Prevention Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ames Co.

- b. Conbraco Industries, Inc.
    - c. FEBCO.
    - d. Watts; a Watts Water Technologies company.
    - e. Zurn Industries, LLC.
  - 2. Standard: ASSE 1015.
  - 3. Operation: Continuous-pressure applications unless otherwise indicated.
  - 4. Pressure Loss: 5 psig maximum, through middle third of flow range.
  - 5. Accessories:
    - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
    - b. Valves NPS 2-1/2 and Larger: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
- C. Carbonated-Beverage-Dispenser, Dual-Check-Valve Backflow Preventers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cash Acme.
    - b. Lancer Corporation.
    - c. Watts; a Watts Water Technologies company.
  - 2. Standard: ASSE 1032.
  - 3. Operation: Continuous-pressure applications.
  - 4. Size: NPS 1/4 or NPS 3/8.
  - 5. Body: Stainless steel.
  - 6. End Connections: Threaded.
- D. Double-Check, Detector-Assembly Backflow Preventers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Ames Co.
    - b. Conbraco Industries, Inc.
    - c. FEBCO.
    - d. Watts; a Watts Water Technologies company.
    - e. Zurn Industries, LLC.
  - 2. Standard: ASSE 1048 and is FM Global approved or UL listed.
  - 3. Operation: Continuous-pressure applications.
  - 4. Pressure Loss: 5 psig maximum, through middle third of flow range.
  - 5. Accessories:
    - a. Valves: Outside-screw and yoke-gate type with flanged ends on inlet and outlet.
    - b. Bypass: With displacement-type water meter, shutoff valves, and reduced-pressure backflow preventer.
- E. Hose-Connection Backflow Preventers:
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conbraco Industries, Inc.
    - b. Watts; a Watts Water Technologies company.
    - c. Woodford Manufacturing Company.
  - 2. Standard: ASSE 1052.
  - 3. Operation: Up to 10-foot head of water back pressure.

## 2.5 BALANCING VALVES

- A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. ITT Corporation.
    - c. Watts; a Watts Water Technologies company.
  2. Type: Ball or Y-pattern globe valve with two readout ports and memory-setting indicator.
  3. Body: Brass or bronze.
  4. Size: Same as connected piping, but not larger than NPS 2.
  5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.
- B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

## 2.6 TEMPERATURE-ACTUATED, WATER MIXING VALVES

- A. Primary, Thermostatic, Water Mixing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Armstrong International, Inc.
    - b. Lawler Manufacturing Company, Inc.
    - c. Leonard Valve Company.
    - d. Powers.
    - e. Symmons Industries, Inc.
    - f. Zurn Industries, LLC.
  2. Standard: ASSE 1017.
  3. Pressure Rating: 125 psig minimum unless otherwise indicated.
  4. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
- B. Individual-Fixture, Water Tempering Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Cash Acme.
    - b. Conbraco Industries, Inc.
    - c. Honeywell Water Controls.
    - d. Lawler Manufacturing Company, Inc.
    - e. Leonard Valve Company.
    - f. Powers.
    - g. Watts; a Watts Water Technologies company.
    - h. Zurn Industries, LLC.
  2. Standard: ASSE 1016, thermostatically controlled, water tempering valve.
  3. Pressure Rating: 125 psig minimum unless otherwise indicated.

## 2.7 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
1. Pressure Rating: 125 psig minimum unless otherwise indicated.
  2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated and for NPS 2-1/2 and larger.
  3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
  - a. Strainers NPS 2 and Smaller: 0.033 inch.
  - b. Strainers NPS 2-1/2 to NPS 4: 0.062 inch.
  - c. Strainers NPS 5 and Larger: 0.125 inch.
6. Drain: Factory-installed, hose-end drain valve.

## **2.8 OUTLET BOXES**

### **A. Clothes Washer Outlet Boxes:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Acorn Engineering Company.
  - b. Guy Gray Manufacturing Co., Inc.
  - c. Oatey.
  - d. Symmons Industries, Inc.
  - e. Watts; a Watts Water Technologies company.
  - f. Zurn Industries, LLC.
2. Mounting: Recessed.
3. Material and Finish: Stainless-steel box and faceplate.
4. Faucet: Combination valved fitting or separate hot- and cold-water valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.
5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.
6. Drain: NPS 2standpipe and P-trap for direct waste connection to drainage piping.
7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.
8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

## **2.9 HOSE BIBBS**

### **A. Hose Bibbs:**

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

## **2.10 WALL HYDRANTS**

### **A. Nonfreeze Wall Hydrants:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Company.
  - c. Watts; a Watts Water Technologies company.
  - d. Woodford Manufacturing Company.
  - e. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig.

4. Operation: Loose key.
5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
6. Inlet: NPS 3/4 or NPS 1.
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounted with cover.
9. Box and Cover Finish: Polished nickel bronze.
10. Operating Keys: Two with each wall hydrant.

B. Vacuum Breaker Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Watts; a Watts Water Technologies company.
  - c. Woodford Manufacturing Company.
  - d. Zurn Industries, LLC.
2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig.
6. Operation: Loose key or wheel handle.
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4.
9. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

**2.11 DRAIN VALVES**

A. Ball-Valve-Type, Hose-End Drain Valves:

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
2. Pressure Rating: 400-psig minimum CWP.
3. Size: NPS 3/4.
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

**2.12 WATER-HAMMER ARRESTERS**

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. AMTROL, Inc.
  - b. Jay R. Smith Mfg. Co.
  - c. Josam Company.
  - d. Precision Plumbing Products.
  - e. Sioux Chief Manufacturing Company, Inc.
  - f. Watts; a Watts Water Technologies company.
  - g. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

## 2.13 AIR VENTS

- A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
  2. Pressure Rating and Temperature: 125-psig minimum pressure rating at 140 deg F.
  3. Float: Replaceable, corrosion-resistant metal.
  4. Mechanism and Seat: Stainless steel.
  5. Size: NPS 1/2 minimum inlet.
  6. Inlet and Vent Outlet End Connections: Threaded.

## 2.14 TRAP-SEAL PRIMER SYSTEMS

- A. Trap-Seal Primer Systems:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Precision Plumbing Products.
    - b. Zurn Industries, LLC.
  2. Standard: ASSE 1044.
  3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.
  4. Cabinet: Surface-mounted steel box with stainless-steel cover.
  5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
    - 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 application.
  6. Vacuum Breaker: ASSE 1001.
  7. Number Outlets: As shown on drawings.
  8. Size Outlets: NPS 1/2.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
1. Locate backflow preventers in same room as connected equipment or system.
  2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
  3. Do not install bypass piping around backflow preventers.
- B. Install water regulators with inlet and outlet shutoff valves and bypass with memory-stop balancing valve. Install pressure gages on inlet and outlet.
- C. Install water-control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
1. Install cabinet-type units recessed in or surface mounted on wall as specified.



- F. Install Y-pattern strainers for water on supply side of each control valve or water pressure-reducing valve.
- G. Install outlet boxes recessed in wall or surface mounted on wall. Install 2-by-4-inch fire-retardant-treated-wood blocking, wall reinforcement between studs. Comply with requirements for fire-retardant-treated-wood blocking in Section 061000 "Rough Carpentry."
- H. Install water-hammer arresters in water piping according to PDI-WH 201.
- I. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.
- J. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.
- K. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

### **3.2 CONNECTIONS**

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Fire-retardant-treated-wood blocking is specified in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical connections.

### **3.3 LABELING AND IDENTIFYING**

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
  - 1. Pressure vacuum breakers.
  - 2. Intermediate atmospheric-vent backflow preventers.
  - 3. Double-check, backflow-prevention assemblies.
  - 4. Carbonated-beverage-machine backflow preventers.
  - 5. Dual-check-valve backflow preventers.
  - 6. Water pressure-reducing valves.
  - 7. Calibrated balancing valves.
  - 8. Primary, thermostatic, water mixing valves.
  - 9. Outlet boxes.
  - 10. Supply-type, trap-seal primer valves.
  - 11. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Test each pressure vacuum breaker; reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

### **3.5 ADJUSTING**

- A. Set field-adjustable pressure set points of water pressure-reducing valves.

- B. Set field-adjustable flow set points of balancing valves.
- C. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

**END OF SECTION 22 11 19**  
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**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. State of Connecticut Department of Transportation, Standard Specification for Roads, Bridges, Facilities and Incidental Construction, Form 817.
- C. Refer to Specification 312005 for filter fabric.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Pipe and fittings.
  - 2. Nonpressure couplings.
  - 3. Cleanouts.
  - 4. Encasement for piping.
  - 5. Manholes.
  - 6. Resilient pipe connector.
  - 7. Manhole waterproof coating.
  - 8. Special pipe fittings.
  - 9. Warning tape.

**1.3 DEFINITIONS**

- A. DI: Ductile-iron.
- B. PE: Polyethylene
- C. PVC: Polyvinyl Chloride

**1.4 PERFORMANCE REQUIREMENTS**

- A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: At least equal to system test pressure.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated:
  - 1. Pipe.
  - 2. Cleanouts.
  - 3. Encasement for Piping.
  - 4. Manhole waterproof coating.
  - 5. Resilient pipe connector.
  - 6. Transition couplings.
- B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Product Certificates: For each type of soil pipe and fitting, from manufacturer.
- B. Field quality-control reports.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Do not store plastic pipe and fittings in direct sunlight.
- B. Protect pipe, pipe fittings, and seals from dirt and damage.
- C. Handle manholes according to manufacturer's written rigging instructions.

**1.8 PROJECT CONDITIONS**

- A. Interruption of Existing Sanitary Sewerage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
  - 1. Do not proceed with interruption of service without Engineer's and Owner's written permission.

**PART 2 - PRODUCTS**

**2.1 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS (VENT PIPING)**

- A. Refer to Section 221316 "Sanitary Waste and Vent Piping" for additional information.
- B. Install PE encasement on all underground cast-iron piping.

**2.2 DUCTILE-IRON, GRAVITY SEWER PIPE AND FITTINGS (GREASE WASTE AND WASTE)**

- A. Pipe: ASTM A 746, H2 rated epoxy coated on interior, for push-on joints.
- B. Standard Fittings: AWWA C110, ductile or gray iron, for push-on joints.
- C. Compact Fittings: AWWA C153, ductile iron, for push-on joints.
- D. Gaskets: AWWA C111, rubber.
- E. Install 1" thick AP/Armaflex sheet and roll insulation on all grease waste piping. Install PE encasement over insulated pipe.
- F. Install PE encasement on all underground ductile-iron piping.

**2.3 PVC PIPE AND FITTINGS (GRAVITY SANITARY)**

- A. PVC Sewer Pipe and Fittings (NPS 15 and Smaller):
  - 1. Pipe: ASTM D 3034, SDR 35, PVC sewer pipe with bell-and-spigot ends for gasketed joints.
  - 2. Fittings: ASTM D 3034, PVC with bell ends.
  - 3. Gaskets: ASTM F 477, elastomeric seals.

**2.4 NONPRESSURE-TYPE TRANSITION COUPLINGS**

- A. Sleeve-Type Pipe Coupling: ASTM C 1173, rubber or elastomeric sleeve and band assembly fabricated to mate with OD of pipes being joined, for nonpressure joints.
  - 1. Sleeve Material for Cast-Iron and Ductile Iron Soil Pipe: ASTM C 564, rubber.
  - 2. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
  - 3. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.
  - 4. Bands: Stainless steel, at least one at each pipe insert.

- B. Bushing-Type Pipe Couplings: ASTM C 1173, rubber or elastomeric bushing fabricated to mate with OD of smaller pipe and ID of adjoining larger pipe, for nonpressure joint.
1. Sleeve Material for Cast-Iron and Ductile Iron Soil Pipe: ASTM C 564, rubber.
  2. Sleeve Material for Plastic Pipe: ASTM F 477, elastomeric seal.
  3. Sleeve Material for Dissimilar Pipe: Compatible with pipe materials being joined.

## **2.5 CLEANOUTS**

- A. Ductile-Iron Cleanouts:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Josam Company.
    - b. MIFAB, Inc.
    - c. Smith, Jay R. Mfg. Co.
    - d. Tyler Pipe.
    - e. Watts Water Technologies, Inc.
    - f. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
  2. Description: ASME A112.36.2M, round, ductile-iron housing with clamping device and round, secured, scoriated, gray-iron cover. Include ductile-iron ferrule with inside calk or spigot connection and countersunk, tapered-thread, brass closure plug.
  3. Top-Loading Classification(s): Heavy Duty.
  4. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, ductile-iron soil pipe and fittings.

## **2.6 ENCASEMENT FOR PIPING**

- A. Standard: ASTM A 674 or AWWA C105.
- B. Material: Linear low-density polyethylene film of 0.008-inch.
- C. Form: Sheet or tube.
- D. Color: Green.

## **2.7 MANHOLES**

- A. Standard Precast Concrete Manholes:
1. Description: ASTM C 478, precast, reinforced concrete, of depth indicated, with provision for sealant joints.
  2. Diameter: 48 inches minimum unless otherwise indicated.
  3. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
  4. Base Section: 6-inch minimum thickness for floor slab and 4-inch minimum thickness for walls and base riser section; with separate base slab or base section with integral floor.
  5. Riser Sections: 4-inch minimum thickness, of length to provide depth indicated.
  6. Top Section: Eccentric-cone type unless concentric-cone or flat-slab-top type is indicated; with top of cone of size that matches grade rings.
  7. Joint Sealant: ASTM C 990, bitumen or butyl rubber.
  8. Resilient Pipe Connectors: ASTM C 923, cast or fitted into manhole walls, for each pipe connection.
    - a. Kor-n-Seal.

9. Steps: Individual FRP steps; wide enough to allow worker to place both feet on one step and designed to prevent lateral slippage off step. Cast or anchor steps into sidewalls at 12- to 16-inch intervals. Omit steps if total depth from floor of manhole to finished grade is less than 36 inches.
10. Install frame over a minimum of three layers (8 inches) of concrete brick, continuous around frame to allow vertical adjustment.
11. Mortar for Chimney, Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.
12. Protective Coating: Plant-applied, waterproofing; 15-mil minimum thickness applied to exterior surfaces, including chimneys.

B. Manhole Frames and Covers:

1. Description: Ferrous; size as indicated on drawings. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER" or as required by local authority.
2. Material: ASTM A 48/A 48M, Class 35 gray iron unless otherwise indicated. Designed for AASHTO H20 structural loading.

**2.8 CONCRETE**

A. General: Cast-in-place concrete; refer to Section 033100 "Site Cast-In-Place Concrete" unless specified below.

B. Portland Cement Design Mix for Precast Concrete: 4000 psi minimum, with 0.45 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

C. Manhole Channels and Benches: If factory-formed, use same concrete as specified above for pre-cast. If field-formed, refer to Section 033100 "Site Cast-In-Place Concrete."

1. Channels: Concrete invert, formed to same width as connected piping, with 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 manhole.

2. Benches: Concrete, sloped to drain into channel.

- a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water/cementitious materials ratio.

1. Reinforcing Fabric: ASTM A 185/A 185M, steel, welded wire fabric, plain.
2. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420 MPa) deformed steel.

**2.9 MISCELLANEOUS MATERIALS**

A. Waterproof Coating:

1. Bay Oil, "Ebony."
2. Hydrocide 700B.
3. PPS 922 Superseal.

**PART 3 - EXECUTION**

**3.1 EARTHWORK**

- A. Excavating, trenching, and backfilling are specified in Section 312000 "Earth Moving."

**3.2 PIPING INSTALLATION**

- A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.
- B. Install piping beginning at low point, true to grades and alignment indicated with 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, cements, and other installation requirements.
- C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.
- D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.
- E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.
- F. Install gravity-flow, nonpressure, drainage piping according to the following:
  - 1. Install piping pitched down in direction of flow, at minimum slope of 2 percent unless otherwise indicated.
  - 2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use corrosion-resistant rods, pipe or fitting manufacturer's proprietary restraint system, or cast-in-place-concrete supports or anchors.
  - 3. Install piping with 48-inch minimum cover, unless otherwise indicated.
  - 4. Install hub-and-spigot, cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook."
  - 5. Install ductile-iron, gravity sewer piping according to ASTM A 746.
  - 6. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
- G. Install corrosion-protection piping encasement over the following underground metal piping according to ASTM A 674 or AWWA C105:
  - 1. Hub-and-spigot, cast-iron soil pipe.
  - 2. Ductile-iron pipe and fittings.
  - 3. Expansion joints and deflection fittings.
- H. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

**3.3 PIPE JOINT CONSTRUCTION**

- A. Join gravity-flow, nonpressure, drainage piping according to the following:
  - 1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
  - 2. Join ductile-iron, gravity sewer piping according to AWWA C600 for push-on joints.
  - 3. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric-gasket joints.



4. Join dissimilar pipe materials with nonpressure-type, flexible couplings.
- B. Pipe couplings, expansion joints, and deflection fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
1. Use nonpressure flexible couplings where required to join gravity-flow, nonpressure sewer piping unless otherwise indicated.

### **3.4 MANHOLE INSTALLATION**

- A. General: Install manholes complete with appurtenances and accessories indicated.
- B. Install precast concrete manhole sections with sealants according to ASTM C 891.
- C. Form continuous concrete channels and benches between inlets and outlet.
- D. Set covers flush with finished surface for manholes that occur in pavements. Set covers flush with topsoil and provide a graded transition away from covers to surrounding grade.

### **3.5 CONCRETE PLACEMENT**

- A. Place cast-in-place concrete according to ACI 318.

### **3.6 CLEANOUT INSTALLATION**

- A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use ductile-iron soil pipe fittings in sewer pipes at branches for cleanouts, and use ductile-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.
1. Use Heavy-Duty, top-loading classification cleanouts. Provide round 12-inch deep double flanged housing with secured scoriated ductile-iron cover with lifting device, gasket seal, vandal-proof screws and bronze plug.
- B. Refer to detail on Contract Drawings for cleanout installation.

### **3.7 CONNECTIONS**

- A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Section 221316 "Sanitary Waste and Vent Piping."
- B. Make connections to existing piping and underground manholes.
1. Use commercially manufactured wye fittings for piping branch connections. Remove section of existing pipe, install wye fitting into existing piping, and encase entire wye fitting plus 6-inch overlap with not less than 6 inches of concrete with 28-day compressive strength of 3000 psi.
  2. Grout between edge of manhole knockout and exterior wall of piping at manhole connection.
  3. Protect existing piping and manholes to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.
- C. Connect to grease interceptors specified in Section 221323 "Sanitary Waste Interceptors."

### **3.8 CLOSING ABANDONED SANITARY SEWER SYSTEMS**

- A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:
1. Close open ends of piping with at least 8-inch- thick, brick masonry bulkheads.

2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.
- B. Abandoned Manholes: Excavate around manhole as required and use either procedure below:
1. Remove manhole and close open ends of remaining piping.
  2. Remove top of manhole down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.
- C. Backfill to grade according to Section 312000 "Earth Moving."

### **3.9 IDENTIFICATION**

- A. Comply with requirements in Section 312000 "Earth Moving" for underground utility identification devices. Arrange for installation of detectable warning tapes 18 to 24 inches directly over piping and at outside edges of underground manholes.

### **3.10 FIELD QUALITY CONTROL**

- A. Inspect 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 completion of Project.
1. Submit separate report for each system inspection.
  2. Defects requiring correction include the following:
    - a. Alignment: Less than full diameter of inside of pipe is visible between structures.
    - b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
    - c. Damage: 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. Reinspect and repeat procedure until results are satisfactory.
- B. 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 requirements of authorities having jurisdiction.
  3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
  4. Submit separate report for each test.
  5. Gravity PVC Pipe Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction. If there are no requirements by the authorities having jurisdiction, use one of the following:
    - a. Air Test: UNI-B-6 and ASTM F 1417.
    - b. Hydrostatic Test (Infiltration): When the groundwater is 2 feet or more above the crown of the pipe at the upper end of the sections to be tested, an infiltration test shall be made. The upper end of the section to be tested shall be plugged and a V-notch weir of appropriate size shall be fitted into the lower end so as to prevent leakage around the weir plate. The gain of water into the system over a period of at least 4 hours shall then be measured and the leakage rate calculated. The infiltration leakage rate shall not exceed 100 gallons per inch of pipe diameter per mile of pipe per 24 hours.
    - c. Hydrostatic Test (Exfiltration): When the groundwater is not present as described in the hydrostatic (infiltration) test, an exfiltration test shall be made. The sewer shall be plugged at the lower manhole in the outlet pipe and at the upper manhole in the inlet pipe. Water shall be introduced at the lower manhole and the line filled to a point 2 feet above the crown

of the pipe at the upper manhole. Before any measurements are made, a period of 2 hours shall be permitted to allow for absorption and escape of trapped air. Water shall be reintroduced at the lower manhole and the line filled to a point 2 feet above the crown of the pipe at the upper manhole. The loss of water from the system over a period of at least 4 hours shall then be measured and the leakage rate calculated. The exfiltration leakage rate shall not exceed 100 gallons per inch of pipe diameter per mile of pipe.

6. Manhole Tests:

- a. If any part of the manhole is within the water table, perform a negative air pressure test in accordance with ASTM C 1244.
- b. If manhole is not within the water table, perform hydrostatic test in accordance with ASTM C 969.

C. Damage, leaks and loss in test pressure below limits stated above, constitute defects that must be repaired.

D. 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 interior of piping. Flush with potable water.

**3.12 AS-BUILT DRAWINGS**

A. The contractor shall provide as-built drawings (PDF and electronic files in AutoCAD Civil 3D format, latest edition) on a monthly basis. As work progresses, all construction activities shall be documented. The as-built drawings shall include:

1. All demolition and abandonment of underground utilities and structures.
2. Location, elevation, and type (size and quantity) of installed underground utilities and piping. Location, elevation, and type of existing exposed utilities during installation of new work, vaults, manholes, transformers, valves, above- and below-ground conduits, walls, bridges, signs, fences, structural fill, and any other surface and subsurface elements as defined in the specifications.
3. The contractor shall hire the services of a surveyor licensed in the state where the work is being performed to determine parameters stated above of completed work and record the results and update the electronic files. As-builts shall include lateral and vertical (depth) locations of all utilities at 50 foot increments and changes in direction.
4. Document installation with photographs in digital format, especially but not limited to, installation and restraints, tapping sleeves, joining of dissimilar materials, anchors and thrust blocks, valves and hydrants, bedding material, and pipe connections to buildings.
5. Final as-built documents (PDF drawings and electronic files in AutoCAD Civil 3D format, latest edition), shall be submitted to the designated Owner's representative not later than 30 days after substantial completion of the project. All comments shall be incorporated to the final documents within 14 days after receiving them from the Owner's representative. The final record set (hard copy and the electronic files) shall be submitted to the Owner's representative.

**END OF SECTION 22 13 13**  
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## **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. Pipe, tube, and fittings.
  - 2. Specialty pipe fittings.
  - 3. Encasement for underground metal piping.

### **1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

### **1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

## **PART 2 - PRODUCTS**

### **2.1 PERFORMANCE REQUIREMENTS**

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
  - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
  - 2. Waste, Force-Main Piping: 100 psig.

### **2.2 PIPING MATERIALS**

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

### **2.3 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy classes.
  - 1. All cast-iron soil pipe and fittings shall be marked with the collective trademark of the Cast-Iron Soil Pipe Institute (CISPI) and be listed by NSF International.
- B. Gaskets: ASTM C 564, rubber.
- C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

### **2.4 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS**

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
  - 1. All cast-iron soil pipe and fittings shall be marked with the collective trademark of the Cast-Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

B. Heavy-Duty, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. ANACO-Husky; SD-2000 heavy-duty coupling.
  - b. Clamp-All Corp.; HI-TORQ 125 heavy-duty coupling.
  - c. Mission Rubber Company, LLC; a division of MCP Industries; "HW" series heavy-duty coupling.
  - d. Ideal Tridon; heavy-duty "MD" coupling.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop. Couplings shall be 4-band minimum. Coupling shields shall be heavy-duty Type 301 AISI stainless steel.

C. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Charlotte Pipe and Foundry Company.
  - b. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

**2.5 COPPER TUBE AND FITTINGS**

- A. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
- B. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
- C. Copper Pressure Fittings:
  1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
- D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

**2.6 SPECIALTY PIPE FITTINGS**

- A. Transition Couplings:
  1. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.
  2. Unshielded, Nonpressure Transition Couplings:
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Dallas Specialty & Mfg. Co.
      - 2) Fernco Inc.
      - 3) Froet Industries LLC.
      - 4) Mission Rubber Company, LLC; a division of MCP Industries.
      - 5) Plastic Oddities.
    - b. Standard: ASTM C 1173.
    - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
    - d. End Connections: Same size as and compatible with pipes to be joined.

- e. Sleeve Materials:
  - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
  - 2) For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
  - 3) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
  
- 3. Shielded, Nonpressure Transition Couplings:
  - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cascade Waterworks Mfg. Co.
    - 2) Mission Rubber Company, LLC; a division of MCP Industries.
  
  - b. Standard: ASTM C 1460.
  - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
  - d. End Connections: Same size as and compatible with pipes to be joined.

### **PART 3 - EXECUTION**

#### **3.1 EARTH MOVING**

- A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Earth Moving."

#### **3.2 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
  - 1. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
  - 2. Install piping as indicated unless deviations to layout are approved on coordination drawings.
  
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
  
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
  
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
  
- E. Install piping to permit valve servicing.
  
- F. Install piping at indicated slopes.
  
- G. Install piping free of sags and bends.
  
- H. Install fittings for changes in direction and branch connections.
  
- I. Install piping to allow application of insulation.
  
- J. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified.
  
- K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends.

1. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical.
  2. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe.
    - a. Straight tees, elbows, and crosses may be used on vent lines.
  3. Do not change direction of flow more than 90 degrees.
  4. Use proper size of standard increasers and reducers if pipes of different sizes are connected.
    - a. Reducing size of waste piping in direction of flow is prohibited.
- L. Lay buried building waste piping beginning at low point of each system.
1. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream.
  2. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.
  3. Maintain swab in piping and pull past each joint as completed.
- M. Install soil and waste and vent piping at code-required minimum slopes unless otherwise indicated.
1. Vent Piping: 1/8-inch per foot down toward vertical fixture vent or toward vent stack.
- N. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- O. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- P. Plumbing Specialties:
1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary waste gravity-flow piping.
    - a. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
  2. Install drains in sanitary waste gravity-flow piping.
    - a. Comply with requirements for drains specified in Section 221319.13 "Sanitary Drains."
- Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- R. Install sleeves for piping penetrations of walls, ceilings, and floors.
1. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- S. Install sleeve seals for piping penetrations of concrete walls and slabs.
1. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install escutcheons for piping penetrations of walls, ceilings, and floors.

1. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

### **3.3 JOINT CONSTRUCTION**

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.
- C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- D. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

### **3.4 SPECIALTY PIPE FITTING INSTALLATION**

- A. Transition Couplings:
  1. Install transition couplings at joints of piping with small differences in ODs.
  2. In Waste Drainage Piping: Shielded, nonpressure transition couplings.
- B. Dielectric Fittings:
  1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
  2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples.
  3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flange kits.
  4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

### **3.5 HANGER AND SUPPORT INSTALLATION**

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

### **3.6 CONNECTIONS**

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect waste and vent piping to the following:
  1. Plumbing Fixtures: Connect waste piping in sizes indicated, but not smaller than required by plumbing code.
  2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
  3. Plumbing Specialties: Connect waste and vent piping in sizes indicated, but not smaller than required by plumbing code.
  4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
  5. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
  6. Equipment: Connect waste piping as indicated.



- a. Provide shutoff valve if indicated and union for each connection.
  - b. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
- 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.
  - 2. Install flanges, in piping NPS 2-1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

### **3.7 IDENTIFICATION**

- A. Identify exposed sanitary waste and vent piping.
- B. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### **3.8 FIELD QUALITY CONTROL**

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
  - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
  - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary waste and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
  - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired.
    - a. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  - 2. Leave uncovered and unconcealed new, altered, extended, or replaced waste and vent piping until it has been tested and approved.
    - a. Expose work that was covered or concealed before it was tested.
  - 3. Roughing-in Plumbing Test Procedure: Test waste and vent piping except outside leaders on completion of roughing-in.
    - a. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water.
    - b. From 15 minutes before inspection starts to completion of inspection, water level must not drop.
    - c. Inspect joints for leaks.
  - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight.

- a. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg.
  - b. Use U-tube or manometer inserted in trap of water closet to measure this pressure.
  - c. Air pressure must remain constant without introducing additional air throughout period of inspection.
  - d. Inspect plumbing fixture connections for gas and water leaks.
5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
  6. Prepare reports for tests and required corrective action.

### **3.9 CLEANING AND PROTECTION**

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect sanitary waste and vent piping during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.
- D. Repair damage to adjacent materials caused by waste and vent piping installation.

### **3.10 PIPING SCHEDULE**

- A. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
  1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
  2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- B. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
  1. Hubless, cast-iron soil pipe and fittings heavy-duty hubless-piping couplings; and coupled joints.
  2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
  1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- D. Aboveground, vent piping NPS 5 and larger shall be any of the following:
  1. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
- E. Aboveground, condensate drain piping shall be the following:
  1. Type L drawn-temper copper tubing, copper pressure fittings; with soldered joints.
- F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
  1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
  3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- G. Underground, soil and waste piping NPS 5 and larger shall be any of the following:
  1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
  2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; coupled joints.

3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.

**END OF SECTION 22 13 16**  
07/10/2018

**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. Cleanouts.
  - 2. Roof flashing assemblies.
  - 3. Through-penetration firestop assemblies.
  - 4. Miscellaneous sanitary drainage piping specialties.
- B. Related Requirements:
  - 1. Section 221423 "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

**1.3 DEFINITIONS**

- A. ABS: Acrylonitrile-butadiene-styrene.
- B. FOG: Fats, oils, and greases.
- C. PVC: Polyvinyl chloride.

**1.4 ACTION SUBMITTALS**

- A. Shop Drawings:
  - 1. Show fabrication and installation details for frost-resistant vent terminals.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

**1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For sanitary waste piping specialties to include in emergency, operation, and maintenance manuals.

**PART 2 - PRODUCTS**

**2.1 ASSEMBLY DESCRIPTIONS**

- A. Sanitary waste piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary waste piping specialty components.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing, and marked for intended location and application.

**2.2 CLEANOUTS**

A. Cast-Iron Exposed Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Tyler Pipe; a subsidiary of McWane Inc.
  - e. Watts; a Watts Water Technologies company.
  - f. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected drainage piping
4. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Company.
  - c. Oatey.
  - d. Sioux Chief Manufacturing Company, Inc.
  - e. Tyler Pipe; a subsidiary of McWane Inc.
  - f. Watts; a Watts Water Technologies company.
  - g. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M.
3. Size: Same as connected branch.

<b>Floor Cleanouts</b>			
<b>Application</b>	<b>Mfr./Model</b>	<b>Duty Class</b>	<b>Notes</b>
Finished floor	J.R. Smith 4030 series	Foot traffic and medium load wheeled traffic	Polished bronze top; carpet marker for carpeted floor application
Finished floors in hospitals, schools, institutional, etc.	J.R. Smith 4100 series	Heavy load traffic	Polished bronze top
Finished tile, vinyl floors	J.R. Smith 4160 series	Foot traffic and medium load wheeled traffic	Polished bronze top
Unfinished floors, areas where cast-iron appearance is acceptable	J.R. Smith 4220 series	Heavy load traffic	Galvanized cast-iron top

C. Cast-Iron Wall Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Tyler Pipe; a subsidiary of McWane Inc.

- e. Watts; a Watts Water Technologies company.
  - f. Zurn Industries, LLC.
2. Standard: ASME A112.36.2M. Include wall access.
  3. Size: Same as connected drainage piping.

<b>Wall Cleanouts</b>		
<b>Application</b>	<b>Mfr./Model</b>	<b>Notes</b>
Wall cleanout - concealed cleanout plugs in walls	J.R. Smith 4434 series	Nickel bronze frame and cover
Wall cleanout - concealed drainage lines	J.R. Smith 4450 series	Polished bronze frame and cover

**2.3 ROOF FLASHING ASSEMBLIES**

A. Roof Flashing Assemblies:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Acorn Engineering Company.
  - b. Thaler Metal Industries Ltd.
  - c. Zurn Industries, LLC.
2. Description: Manufactured assembly made of 4.0-lb/sq. ft., 0.0625-inch- thick, lead flashing collar and skirt extending at least 8 inches from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
  - a. Open-Top Vent Cap: Without cap.

**2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES**

A. Through-Penetration Firestop Assemblies:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. ProSet Systems Inc.
  - b. Approved equal.
2. Standard: UL 1479 assembly of sleeve-and-stack fitting with firestopping plug.
3. Size: Same as connected soil, waste, or vent stack.
4. Sleeve: Molded-PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.

**2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES**

A. Open Drains:

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564 rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.

- B. Deep-Seal Traps:
1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
  2. Size: Same as connected waste piping.
    - a. NPS 2: 4-inch- minimum water seal.
    - b. NPS 2-1/2 and Larger: 5-inch- minimum water seal.
- C. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
  2. Body: Bronze or cast iron.
  3. Inlet: Opening in top of body.
  4. Outlet: Larger than inlet.
  5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.
- D. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
  2. Size: Same as connected stack vent or vent stack.
- E. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
  2. Design: To provide 1-inch enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.
- F. Expansion Joints:
1. Standard: ASME A112.6.4.
  2. Body: Cast iron with bronze sleeve, packing, and gland.
  3. End Connections: Matching connected piping.
  4. Size: Same as connected soil, waste, or vent piping.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
  2. Locate at each change in direction of piping greater than 45 degrees.
  3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
  4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."

- E. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- F. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping."
- G. Assemble open drain fittings and install with top of hub 2 inches above floor.
- H. Install deep-seal traps on floor drains and other waste outlets, if indicated.
- I. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.
  - 1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
  - 2. Size: Same as floor drain inlet.
- J. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.
- K. Install sleeve and sleeve seals with each riser and stack passing through floors with waterproof membrane.
- L. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch clearance between vent pipe and roof substrate.
- M. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.
- N. Install wood-blocking reinforcement for wall-mounting-type specialties.
- O. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

### **3.2 CONNECTIONS**

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### **3.3 FLASHING INSTALLATION**

- A. Comply with requirements in Section 076200 "Sheet Metal Flashing and Trim."
- B. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required.
- C. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
  - 1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.
  - 2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.
  - 3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.



- D. Set flashing on floors and roofs in solid coating of bituminous cement.
- E. Secure flashing into sleeve and specialty clamping ring or device.
- F. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Section 076200 "Sheet Metal Flashing and Trim."
- G. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

**3.4 PROTECTION**

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19**  
07/10/2018

**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. Floor drains.
  - 2. Floor sinks.

**1.3 DEFINITIONS**

- A. ABS: Acrylonitrile-butadiene styrene.
- B. FRP: Fiberglass-reinforced plastic.
- C. HDPE: High-density polyethylene.
- D. PE: Polyethylene.
- E. PP: Polypropylene.
- F. PVC: Polyvinyl chloride.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

**PART 2 - PRODUCTS**

**2.1 DRAIN ASSEMBLIES**

- A. Sanitary drains shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14 for plastic sanitary piping specialty components.

**2.2 FLOOR DRAINS**

- A. Cast-Iron Floor Drains:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Jay R. Smith Mfg. Co.
    - b. Josam Company.
    - c. MIFAB, Inc.
    - d. Zurn Industries, LLC.
  - 2. Standard: ASME A112.6.3.
  - 3. Refer to Plumbing Schedules for additional information.

## 2.3 FLOOR SINKS

### A. Floor Sinks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Zurn Industries, LLC.
2. Standard: ASME A112.6.3 for floor sinks.
3. Refer to Plumbing Schedules for additional information.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
  1. Install floor-drain and floor-sink flashing collar or flange, so no leakage occurs between drain and adjoining flooring.
    - a. Maintain integrity of waterproof membranes where penetrated.
  2. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.
- B. Install open drain fittings with top of hub 2 inches above floor.

### 3.2 CONNECTIONS

- A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Comply with requirements in Section 221319 "Sanitary Waste Piping Specialties" for backwater valves, air admittance devices and miscellaneous sanitary drainage piping specialties.
- C. Install piping adjacent to equipment to allow service and maintenance.
- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 3.3 LABELING AND IDENTIFYING

- A. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

### 3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

**END OF SECTION 22 13 19.13**  
07/10/2018

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## **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. This Section includes the following types of interceptors outside the building:
  - 1. Grease interceptors.

### **1.3 DEFINITIONS**

- A. HDPE: High-density polyethylene plastic.
- B. PE: Polyethylene plastic.

### **1.4 SUBMITTALS**

- A. Shop Drawings: For each type and size of precast concrete interceptor indicated.
  - 1. Include materials of construction, dimensions, rated capacities, retention capacities, location and size of each pipe connection, furnished specialties, and accessories.
- B. Coordination Drawings: Interceptors, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Interceptors.
  - 2. Piping connections. Include size, location, and elevation of each.
  - 3. Interface with underground structures and utility services.

### **1.5 PROJECT CONDITIONS**

- A. Interruption of Existing Sewer Services: Do not interrupt services to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary sewer services according to requirements indicated:
  - 1. Notify Owner no fewer than seven days in advance of proposed interruption of service.
  - 2. Do not proceed with interruption of sewer services without Owner's written permission.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers:
    - a. Old Castle Precast.
    - b. United Concrete Precast.
    - c. CT Precast.
    - d. Arrow Concrete.
    - e. Eastern Precast.

## **2.2 GREASE INTERCEPTORS**

- A. Grease Interceptors: Precast concrete complying with ASTM C 913. Include rubber-gasketed joints, vent connections, manholes, compartments or baffles, and piping or openings to retain grease and to permit wastewater flow.
1. Protective Coating: Plant applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil (0.38-mm) minimum thickness applied to all exterior concrete surfaces. Plant applied to all interior surfaces, 125-mil minimum thickness epoxy coating rated for up to 235 degree F media temperature, #4553 by Standard Materials or FloroCrete HD 3.0 by Florock. Field re-apply all joints on interior and exterior.
  2. Structural Design Loads:
    - a. Heavy-Traffic Load: Comply with ASTM C 890, A-16 (ASSHTO HS20-44).
  3. Resilient Pipe Connectors: ASTM C 923, cast or fitted into interceptor walls, for each pipe connection.
  4. Grade Rings: Reinforced-concrete rings, 6- to 9-inch total thickness, to match diameter of manhole frame and cover.
  5. Manhole Frames and Covers: Ferrous; 32-inch ID by 7- to 9-inch riser with 4-inch- minimum width flange and 26-inch- diameter cover.
    - a. Ductile Iron: ASTM A 536, Grade 60-40-18, unless otherwise indicated.
    - b. Include indented top design with lettering cast into cover, using wording equivalent to "GREASE INTERCEPTOR."
    - c. Protective Coating: Foundry-applied, SSPC-Paint 16, coal-tar, epoxy-polyamide paint; 15-mil minimum thickness applied to all ferrous surfaces.
- B. Grease Interceptor Capacity and Characteristics:
1. As specified on drawings.

## **PART 3 - EXECUTION**

### **3.1 EARTHWORK**

- A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

### **3.2 INSTALLATION**

- A. Install interceptor inlets and outlets at elevations indicated.
- B. Install precast concrete interceptors according to ASTM C 891. Set level and plumb.
- C. Install manhole risers from top of underground concrete interceptors to manholes and gratings at finished grade.
- D. Set tops of manhole frames and covers flush with finished surface in pavements. Set tops 3 inches above finish surface elsewhere, unless otherwise indicated.
- E. Set tops of grating frames and grates flush with finished surface.
- F. Precast concrete tank sections shall be painted on exterior and interior by the tank manufacturer. Field painting shall be limited to tank joints and repairs of the interior and exterior surfaces.

- G. Clean and prepare concrete surfaces to be field painted. Remove loose efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen surface as required to remove glaze. Paint the following concrete surfaces as recommended by paint manufacturer:
  - 1. Precast Concrete Interceptors: All exterior and interior joints and repaired areas.
- H. Clean and prepare metal surfaces to be field painted according to SSPC- PA 1. Paint the following metal surfaces according to SSPC-PA 1 and SSPC-Paint 16:
  - 1. Metal Manhole Frames and Covers (Including Grates): All surfaces.
  - 2. Do not paint metal surfaces with factory-applied, corrosion-resistant coating.

### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Make piping connections between interceptors and piping systems.

### **3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Hire testing agency and perform test as described below in presence of the Owner's Representative and Engineer. Provide written reports for all tests performed.
- B. Testing Services: Provide a leakage test in accordance with one of the following methods:
  - 1. Vacuum Test: Assemble empty tank including temporary sealing of inlet and outlet pipes and all access openings. Attach a vacuum device that is capable of drawing a minimum vacuum pressure of 7 inches of mercury (Hg). To measure negative pressure drawn, the vacuum device shall utilize a calibrated gauge (range no greater than 0 to 10 inches/Hg), mercury manometer or water manometer accurate to within 0.2 inches/Hg. Apply a vacuum to 4 inches/Hg. Tank passes leakage test once negative pressure is held for 5 minutes without loss of pressure. If the tank fails test, then the tank can be repaired per manufacturer's recommendations and retested.
  - 2. Water Pressure Test: Seal the tank. Fill with water and let stand for 24 hours. Re-fill the tank. The tank passes the leakage test if the water level is held for one hour.

### **3.5 IDENTIFICATION**

- A. Identification materials and installation are specified in Division 22 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping and at outside edges of underground interceptors.
  - 1. Use detectable warning tape over ferrous piping.
  - 2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

### **3.6 AS-BUILT DRAWINGS**

- A. The contractor shall provide as-built drawings (PDF and electronic files in AutoCAD Civil 3D format, latest edition) on a monthly basis. As work progresses, all construction activities shall be documented. The as-built drawings shall include:
  - 1. All demolition and abandonment of underground utilities and structures.
  - 2. Location, elevation, and type (size and quantity) of installed underground utilities and piping. Location, elevation, and type of existing exposed utilities during installation of new work, vaults, manholes, transformers, valves, above- and below-ground conduits, walls, bridges, signs, fences, structural fill, and any other surface and subsurface elements as defined in the specifications.
  - 3. The contractor shall hire the services of a surveyor licensed in the state where the work is being performed to determine parameters stated above of completed work and record the results and update the electronic files. As-builts shall include lateral and vertical (depth) locations of all utilities at 50 foot increments and changes in direction.



4. Document installation with photographs in digital format, especially but not limited to, installation and cleanouts, joining of dissimilar materials, bedding material, and pipe connections to buildings and structures.
5. Final as-built documents (PDF drawings and electronic files in AutoCAD Civil 3D format, latest edition), shall be submitted to the designated Owner's representative not later than 30 days after substantial completion of the project. All comments shall be incorporated to the final documents within 14 days after receiving them from the Owner's representative. The final record set (hard copy and the electronic files) shall be submitted to the Owner's representative.

**END OF SECTION 22 13 23**  
07/10/2018

## **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. Water closets.
  - 2. Flushometer valves.
  - 3. Toilet seats.
  - 4. Supports.

### **1.3 DEFINITIONS**

- A. Effective Flush Volume: Average of two reduced flushes and one full flush per fixture.
- B. Remote Water Closet: Located more than 30 feet from other drain line connections or fixture and where less than 1.5 drainage fixture units are upstream of the drain line connection.

### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

### **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

## **PART 2 - PRODUCTS**

### **2.1 WALL-MOUNTED WATER CLOSETS**

- A. Water Closets: Wall mounted, top spud, accessible.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Kohler Co.

- b. Sloan Valve Company.
  - c. American Standard America
  - d. Zurn Industries, LLC.
2. Bowl:
- a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
  - b. Material: Vitreous china.
  - c. Type: Siphon jet.
  - d. Style: Flushometer valve.
  - e. Height: Standard.
  - f. Rim Contour: Elongated.
  - g. Water Consumption: 1.28 gal. per flush.
  - h. Spud Size and Location: NPS 1-1/2; top.
3. Toilet Seat: Open front, elongated.
4. Support: Water closet carrier.
5. Water-Closet Mounting Height: As noted on drawings.

## 2.2 FLUSHOMETER VALVES

### A. Solenoid-Actuator, Diaphragm Flushometer Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
- a. Sloan Valve Company.
  - b. Zurn Industries, LLC.
  - c. Delany Products.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
9. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951, and listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
10. Consumption: 1.28 gal. per flush.
11. Minimum Inlet: NPS 1.
12. Minimum Outlet: NPS 1-1/4.

## 2.3 TOILET SEATS

### A. Toilet Seats:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
- a. Church Seats; Bemis Manufacturing Company.
  - b. Kohler Co.
  - c. Olsonite Seat Co.
  - d. TOTO USA, INC.
  - e. Zurn Industries, LLC.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.

4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

## **2.4 SUPPORTS**

### **A. Water Closet Carrier:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Zurn Industries, LLC.
  - b. Jay R. Smith Mfg. Co.
2. Standard: ASME A112.6.1M.
3. Description: Waste-fitting assembly, as required to match drainage piping material and arrangement with faceplates, couplings gaskets, and feet; bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

#### **A. Water-Closet Installation:**

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height for handicapped/elderly, according to ICC/ANSI A117.1.

#### **B. Support Installation:**

1. Use carrier supports with waste-fitting assembly and seal.
2. Install wall-mounted, back-outlet water-closet supports with waste-fitting assembly and waste-fitting seals; and affix to building substrate.

#### **C. Flushometer-Valve Installation:**

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
3. Install lever-handle flushometer valves for accessible water closets with handle mounted on open side of water closet.
4. Install actuators in locations that are easy for people with disabilities to reach.

#### **D. Install toilet seats on water closets.**

- E. Wall Flange and Escutcheon Installation:
  - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
  - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
  - 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
  
- F. Joint Sealing:
  - 1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
  - 2. Match sealant color to water-closet color.
  - 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

### **3.3 CONNECTIONS**

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

### **3.4 ADJUSTING**

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

### **3.5 CLEANING AND PROTECTION**

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 13.13**  
07/10/2018

**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. Urinals.
  - 2. Flushometer valves.
  - 3. Supports.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for urinals.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For flushometer valves and electronic sensors to include in operation and maintenance manuals.

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.
  - 2. Waterless Urinal Trap-Seal Cartridges: Equal to 200 percent of amount of each type installed, but no fewer than 12 of each type.
  - 3. Waterless Urinal Trap-Seal Liquid: Equal to 1 gal. for each urinal installed.

**PART 2 - PRODUCTS**

**2.1 WALL-HUNG URINALS**

- A. Urinals: Wall hung, back outlet, washout, accessible.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Kohler Co.
    - b. Sloan Valve Company.
    - c. American Standard America.
    - d. Zurn Industries, LLC.

2. Fixture:
  - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
  - b. Material: Vitreous china.
  - c. Type: Washout with extended shields.
  - d. Strainer or Trapway: Manufacturer's standard strainer with integral trap.
  - e. Water Consumption: Water saving.
  - f. Spud Size and Location: NPS 3/4, top.
  - g. Outlet Size and Location: NPS 2, back.
  - h. Color: White.
3. Waste Fitting:
  - a. Standard: ASME A112.18.2/CSA B125.2 for coupling.
  - b. Size: NPS 2.
4. Support: Type I Urinal Carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture. Include rectangular, steel uprights..
5. Urinal Mounting Height: Standard and handicapped/elderly according to ICC A117.1.

## **2.2 URINAL FLUSHOMETER VALVES**

### **A. Solenoid-Actuator, Diaphragm Flushometer Valves:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Sloan Valve Company.
  - b. Zurn Industries, LLC.
2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig.
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Style: Exposed.
8. Actuator: Solenoid complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
9. Trip Mechanism: Hard-wired electronic sensor complying with UL 1951; listed and labeled as defined in NFPA 70, by a qualified testing agency; and marked for intended location and application.
10. Consumption: 0.125 gal. per flush.
11. Minimum Inlet: NPS 3/4.
12. Minimum Outlet: NPS 1-1/4.

## **2.3 SUPPORTS**

### **A. Type I Urinal Carrier:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Jay R. Smith Mfg. Co.
  - b. Josam Company.
  - c. MIFAB, Inc.
  - d. Wade Drains.
  - e. Watts; a Watts Water Technologies company.
  - f. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

**B. Type II Urinal Carrier:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

- a. Jay R. Smith Mfg. Co.
- b. Josam Company.
- c. MIFAB, Inc.
- d. Wade Drains.
- e. Watts; a Watts Water Technologies company.
- f. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

**C. Type I Sink Carrier:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

- a. Jay R. Smith Mfg. Co.
- b. Josam Company.
- c. MIFAB, Inc.
- d. Wade Drains.
- e. Watts; a Watts Water Technologies company.
- f. Zurn Industries, LLC.

2. Standard: ASME A112.6.1M.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before urinal installation.
- B. Examine walls and floors for suitable conditions where urinals will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

**A. Urinal Installation:**

1. Install urinals level and plumb according to roughing-in drawings.
2. Install wall-hung, back-outlet urinals onto waste fitting seals and attached to supports.
3. Install accessible, wall-mounted urinals at mounting height for the handicapped/elderly, according to ICC/ANSI A117.1.
4. Install trap-seal liquid in waterless urinals.

**B. Support Installation:**

1. Install supports, affixed to building substrate, for wall-hung urinals.
2. Use off-floor carriers with waste fitting and seal for back-outlet urinals.
3. Use chair-type carrier supports with rectangular steel uprights for accessible urinals.



- C. Flushometer-Valve Installation:
  - 1. Install flushometer-valve water-supply fitting on each supply to each urinal.
  - 2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.
  
- D. Wall Flange and Escutcheon Installation:
  - 1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations.
  - 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
  - 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
  
- E. Joint Sealing:
  - 1. Seal joints between urinals and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
  - 2. Match sealant color to urinal color.
  - 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

**3.3 CONNECTIONS**

- A. Connect urinals with water supplies and soil, waste, and vent piping. Use size fittings required to match urinals.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to urinals, allow space for service and maintenance.

**3.4 ADJUSTING**

- A. Operate and adjust urinals and controls. Replace damaged and malfunctioning urinals, fittings, and controls.
- B. Adjust water pressure at flushometer valves to produce proper flow.
- C. Install fresh batteries in battery-powered, electronic-sensor mechanisms.

**3.5 CLEANING AND PROTECTION**

- A. Clean urinals and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed urinals and fittings.
- C. Do not allow use of urinals for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 13.16**  
07/10/2018

**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. Lavatories.
  - 2. Faucets.
  - 3. Supports.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Servicing and adjustments of automatic faucets.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

**1.7 QUALITY ASSURANCE**

- A. Massachusetts Board of Registration of Plumbers and Gas Fitters Approval: Products shall be listed in the Accepted Plumbing Products Systems and indicate approval on product submittal.

**PART 2 - PRODUCTS**

**2.1 VITREOUS-CHINA, COUNTER-MOUNTED LAVATORIES**

- A. Lavatory: Oval, self-rimming, vitreous china, counter mounted.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Kohler Co.
  - b. Sloan Valve Company.
  - c. TOTO USA, INC.
  - d. Zurn Industries, LLC.
  
2. Fixture:
  - a. Standard: ASME A112.19.2/CSA B45.1.
  - b. Type: Self-rimming for above-counter mounting.
  - c. Nominal Size: Oval, 20 by 17 inches.
  - d. Faucet-Hole Punching: Three holes, 4-inch centers.
  - e. Faucet-Hole Location: Top.
  - f. Color: White.
  - g. Mounting Material: Sealant.

**2.2 SOLID-BRASS, AUTOMATICALLY OPERATED LAVATORY FAUCETS**

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
  
- B. Lavatory Faucets: Automatic-type, electronic-sensor-operated, mixing, solid-brass valve.
  1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Chicago Faucets; Geberit Company.
    - b. Kohler Co.
    - c. Sloan Valve Company.
    - d. T & S Brass and Bronze Works, Inc.
    - e. TOTO USA, INC.
    - f. Zurn Industries, LLC.
  
  2. Standards: ASME A112.18.1/CSA B125.1 and UL 1951.
  3. 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.
  4. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.

**2.3 SUPPLY FITTINGS**

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
  
- B. Standard: ASME A112.18.1/CSA B125.1.
  
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
  
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
  
- E. Operation: Loose key.
  
- F. Risers:
  1. NPS 1/2.

2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

#### **2.4 WASTE FITTINGS**

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
  1. Size: NPS 1-1/2 by NPS 1-1/4.
  2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated, brass or steel wall flange.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- C. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- D. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

#### **3.3 CONNECTIONS**

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

#### **3.4 ADJUSTING**

- A. Operate and adjust lavatories and controls. Replace damaged and malfunctioning lavatories, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

**3.5 CLEANING AND PROTECTION**

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 16.13**  
07/10/2018

**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. Service basins.
  - 2. Sink faucets.
  - 3. Supply fittings.
  - 4. Waste fittings.
  - 5. Supports.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
  - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

**1.5 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For sinks to include in maintenance manuals.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

**1.7 QUALITY ASSURANCE**

- A. Massachusetts Board of Registration of Plumbers and Gas Fitters Approval: Products shall be listed in the Accepted Plumbing Products Systems and indicate approval on product submittal.

**PART 2 - PRODUCTS**

**2.1 SERVICE BASINS**

- A. Service Basins: Terrazzo, floor mounted.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Fiat

- b. Acorn Engineering Company.
  - c. Crane Plumbing, L.L.C.
  - d. Florestone Products Co., Inc.
  - e. Stern-Williams Co., Inc.
2. Fixture:
- a. Standard: IAPMO PS 99.
3. Mounting: On floor and flush to wall.
4. Faucet: As indicated on drawings.

## 2.2 SINK FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water.
- B. Sink Faucets: Manual type, single-control or two-lever-handle mixing valve.
  - 1. Commercial, Solid-Brass Faucets.
    - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
      - 1) Chicago Faucets; Geberit Company.
      - 2) Delta Faucet Company.
      - 3) Elkay Manufacturing Co.
      - 4) Kohler Co.
      - 5) Speakman Company.
      - 6) T & S Brass and Bronze Works, Inc.
      - 7) Zurn Industries, LLC.

## 2.3 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61 Annex G, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Loose key.
- F. Risers:
  - 1. Chrome-plated, rigid-copper pipe.

## 2.4 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.

- C. Trap:
  - 1. Size: NPS 1-1/2.
  - 2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- thick brass tube to wall; and chrome-plated brass or steel wall flange.

## 2.5 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
  - 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
  - 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."



**3.3 CONNECTIONS**

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

**3.4 ADJUSTING**

- A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

**3.5 CLEANING AND PROTECTION**

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 16.16**  
07/10/2018

**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. Shower faucets.
  - 2. Shower basins.
  - 3. Grout.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for showers and basins.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

**1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For shower faucets to include in maintenance manuals.

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

**1.6 QUALITY ASSURANCE**

- A. Massachusetts Board of Registration of Plumbers and Gas Fitters Approval: Products shall be listed in the accepted Plumbing Products Systems and indicate approval on product submittals.

**PART 2 - PRODUCTS**

**2.1 SHOWER FAUCETS**

- A. NSF Standard: Comply with NSF 61 Annex G, "Drinking Water System Components - Health Effects," for shower materials that will be in contact with potable water.
- B. Shower Faucets:
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Symmons Industries, Inc.
    - b. Chicago Faucets; Geberit Company.
    - c. Kohler Co.
    - d. Lawler Manufacturing Company, Inc.
    - e. Moen Incorporated.
    - f. Speakman Company.

- g. Zurn Industries, LLC.
- 2. Description: Single-handle, pressure-balance mixing valve with hot- and cold-water indicators; check stops; and shower head.
- 3. Faucet:
  - a. Standards: ASME A112.18.1/CSA B125.1 and ASSE 1016.
- 4. Shower Head:
  - a. Standard: ASME A112.18.1/CSA B125.1.

## **2.2 GROUT**

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine roughing-in of water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before shower installation.
- B. Examine walls and floors for suitable conditions where showers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

- A. Assemble shower components according to manufacturers' written instructions.
- B. Install showers level and plumb according to roughing-in drawings.
- C. Install water-supply piping with stop on each supply to each shower faucet.
  - 1. Exception: Use ball or gate valves if supply stops are not specified with shower. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping" and Section 220523.15 "Gate Valves for Plumbing Piping."
  - 2. Install stops in locations where they can be easily reached for operation.
- D. Install shower flow-control fittings with specified maximum flow rates in shower arms.
- E. Set shower receptors and shower basins in leveling bed of cement grout.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheons requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- G. Seal joints between showers and floors and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

**3.3 CONNECTIONS**

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with traps and soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

**3.4 ADJUSTING**

- A. Operate and adjust showers and controls. Replace damaged and malfunctioning showers, fittings, and controls.
- B. Adjust water pressure at faucets to produce proper flow.

**3.5 CLEANING AND PROTECTION**

- A. After completing installation of showers and basins, inspect and repair damaged finishes.
- B. Clean showers and basins, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed fixtures and fittings.
- D. Do not allow use of showers and basins for temporary facilities unless approved in writing by Owner.

**END OF SECTION 22 42 23**  
07/10/2018

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**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. This section is intended to supplement the requirements of Division 01 requirements. For any conflicting requirements for minimum quantities or quality levels between this Section and Division 01, comply with the most stringent requirement.

**1.2 SUMMARY**

- A. This Section includes the following when associated with Divisions 21, 22, and 23 work:
  - 1. Permits and fees, code requirements, work under other contracts.
  - 2. Work restrictions.
  - 3. Specification formats and conventions.
  - 4. Request for information.
  - 5. Coordination.
  - 6. Conflicting requirements.
  - 7. Quality assurance and control.
  - 8. Product delivery, storage, and handling.
  - 9. Product warranties.
  - 10. Submittals.
  - 11. Product selection procedures.
  - 12. Product interoperability requirements.
  - 13. General execution of project scope of work.
  - 14. Record drawings.
  - 15. Demonstration and training.

- B. Related Sections include the following:
  - 1. Division 01 Sections.

**1.3 PERMITS AND FEES**

- A. Give all necessary notices, obtain all permits; pay all government and state sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Project scope of 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 inspections for Project scope of work and deliver a copy to the Architect/Engineer before request for acceptance and final payment for the Project scope of work.

**1.4 CODE REQUIREMENTS**

- A. Project Code: Confirm the codes in effect at the time of permitting.
- B. Project Legislative Requirements: Confirm the State and Local Legislations in effect at the time of permitting or those that affect construction.
- C. Compliance: Comply with all codes and legislations applicable to the project, including energy related:
  - 1. Means and Methods
  - 2. Equipment and Devices.
  - 3. Materials and Work Product.

**1.5 WORK UNDER OTHER CONTRACTS**

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

**1.6 WORK RESTRICTIONS**

- A. Existing Utility Interruptions: 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:
1. Notify Construction Manager or Owner not less than 10 days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Construction Manager's or Owner's written permission.

**1.7 REQUESTS FOR INFORMATION (RFIs)**

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of Engineer, Architect and Construction Manager.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, product data, shop drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. The following RFIs will be returned without action:
1. Requests for approval of submittals.
  2. Requests for approval of substitutions.
  3. Requests for coordination information already indicated in the Contract Documents.
  4. Requests for adjustments in the Contract Time or the Contract Sum.
  5. Requests for interpretation of Architect's actions on submittals.
  6. Incomplete RFIs or inaccurately prepared RFIs.
- D. Action may include a request for additional information, in which case time for response will date from time of receipt of additional information.

**1.8 COORDINATION**

- A. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.

**1.9 CONFLICTING REQUIREMENTS**

- A. General: If compliance with two or more standards or directives is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

**1.10 MINOR CHANGES IN THE WORK**

- A. Engineer/Architect will issue through the Construction Manager, supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.
- B. Drawings are diagrammatic, the Contractor shall relocate devices a reasonable distance for coordination.
  - 1. A reasonable distance is considered to be 15 feet at no additional cost.

**1.11 QUALITY ASSURANCE AND CONTROL**

- A. General: Qualifications paragraphs in this Article establish some of the minimum qualification levels required; Division 01 and individual Specification Sections specify additional requirements.
- B. Code Compliance: Work and equipment shall comply with all latest applicable codes and legislations.
- C. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those required for this Project.
- D. Instructor Qualifications: A factory-authorized service representative, complying with requirements in "Quality Requirements," experienced in operation and maintenance procedures and training.
- E. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.



- a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
- 2. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
- 3. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- F. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.
- G. **Retesting/Re-inspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- H. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Delivery of samples to testing agencies.
  - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- I. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- J. **Compatibility of Options:** If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
  - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
  - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used at no additional cost to the project.
- K. **Acceptance of Work:** 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 Code, Legislation, the Drawings and/or Specifications. Correct Work not in conformance whenever non-conformance is discovered.

**1.12 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions and generally accepted construction practice.
- B. **Storage:**
  - 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

**1.13 PRODUCT WARRANTIES**

- A. Refer to Division 01 and individual sections for requirements.
- B. The following requirements are supplemental and in addition to those stated in other specific sections and Division 01.
  1. Warranty all materials and workmanship under these Specifications and the Contract for a period of one year from the date of final acceptance by the Owner.
  2. During this warranty period, correct or replace all defects developing through materials or workmanship immediately as directed by the Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction.
- C. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- D. Warranty Start Date: From the date of final acceptance by the Owner.

**1.14 SUBMITTAL PROCEDURES**

- A. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
  1. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
- C. Substitution Requests: Submit four copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  1. Substitution: A submittal shall be considered a substitution when the Engineer/Architect does not accept the product or material as an "equivalent" or where one of the listed manufacturers is not submitted.
  2. Substitution Requirements: Substitutions shall meet the requirements of "Comparable Products."
  3. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified material or product cannot be provided.
    - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.

- c. Detailed comparison of significant qualities of proposed substitution with those of the Project scope of work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
- e. Samples, where applicable or requested.
- f. Cost information, including a proposal of change, if any, in the Contract Sum.
- g. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
- h. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- i. Statement indicating why the requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations.

D. Delegated-Design Services:

- 1. Performance and Design Criteria: Where professional design services or certifications by a design professional are specifically required of the Contractor by the Contract Documents, the Contractor shall provide products and systems complying with specific performance and design indicated.
  - a. If criteria indicated are not sufficient to perform services or certification required, submit a written request for additional information to the Architect.
- 2. Delegated-Design Services Certification: In addition to Shop Drawings, Product Data, and other required submittals, submit digitally signed PDF electronic file copies of certificate, signed and sealed by the responsible design professional, for each product and system specifically assigned to the Contractor to be designed or certified by a design professional.
  - a. Indicate that products and systems comply with performance and design criteria in the Contract Documents. Include list of codes, loads, and other factors used in performing these services.

**1.15 RECORD DRAWINGS AND RECORD DIGITAL FILES**

A. Record Drawings and Record Digital Files: Comply with the following:

- 1. Submit Record Drawings and Record Digital Files as follows:
  - a. Initial Submittal: Submit one set of plots from corrected Record CAD Drawings and one set of marked-up Record Prints. Engineer will initial and date each plot and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. Engineer will return plot for organizing into sets, printing, binding, and final submittal.
  - b. Final Submittal: Submit one set of marked-up Record Prints.
  - c. Final Submittal: Submit three sets of Record CAD Drawing files, and one set of Record CAD Drawing plots. Plot and print each drawing, whether or not changes and additional information were recorded.
    - 1) Electronic Media: CD-R.

B. Qualification Data: For training instructor.

**1.16 PRODUCT SELECTION PROCEDURES**

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

- 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.

2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer and/or Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
6. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

**B. Product Selection Procedures:**

1. Design Basis: The design has been based on the single manufacturer indicated in the contract documents. The Contractor is responsible for verifying prior to submission, that any other manufacturer even though listed complies with dimensional and performance characteristics of the base specified product. Modifications shall be made by the Contractor as part of this contract to accommodate changes to the design basis.
2. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
3. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
4. Equivalent Product: Equipment, material or devices submitted for review as an "accepted equivalent" shall meet all of the following requirements:
  - a. A product of a listed manufacturer.
  - b. The equivalent shall have the same construction features such as, but not limited to:
    - 1) Material thickness, gauge, weight, density, etc.
    - 2) Welded, riveted, bolted, etc., construction
    - 3) Finish, undercoating, corrosion protection
  - c. The equivalent shall perform with the same or better operating efficiency.
  - d. The equivalent shall have equal or greater reserve capacity.
  - e. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  - f. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL, AMCA or ARI labels.

**1.17 PRODUCT INTEROPERABILITY REQUIREMENTS**

- A. Interoperability Coordination Meeting: Attend a minimum of 3 weekly coordination meetings to coordinate interoperability between all systems and equipment. Meetings shall be scheduled by the construction manager.
- B. General Networking and Protocol Interoperability Requirements: Provide products that are fully BACnet interoperable.
  1. All systems and equipment shall interface with the primary building management network provided under "Instrumentation and Controls for HVAC" using Ethernet standards and BACnet protocol.
  2. Equipment that is native BACnet may connect directly to a BACnet MS/TP subnet that is provided by "Instrumentation and Controls for HVAC" when coordinated with that Section Contractor.
  3. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to the most current ANSI/ASHRAE Standard 135, BACnet.
  4. The MS/TP trunks support all of the ASHRAE 135 approved baud rates.
  5. All MS/TP devices support all baud rates of the ASHRAE 135.
  6. All MS/TP devices shall be BTL approved ( BACnet Testing Lab).
  7. All BACnet routers must support B-BC (BIBB) and support BBMD routing.

8. Lonworks and Modbus subnets may be utilized where no BACnet protocol is available provided full 2-way compatibility is provided through a gateway.
    - a. Exception: Fire alarm systems shall be 1-way, read only communication.
  9. Each individual system and/or equipment manufacturer/installer shall provide all necessary gateways/translators Provide Gateway with all products as required facilitating full BACnet interoperability with BACnet Protocol.
  10. It must be possible to read and display the value of any property, including all required properties, supported optional properties, and proprietary extensions of very object of every networked device.
  11. Operating setpoints and parameters must be available for modification via BACnet services via a graphical user interface (GUI).
  12. An operator shall be able to display at any time the operational status of any device on the BACnet internetwork. An operator shall be able to display at any time any property of any BACnet object. An operator shall also be able to display property values of objects grouped by object type, object location, building system, and by user defined parameters.
  13. An operator shall have the ability to issue re-initialization commands to any device that supports remote re-initialization.
  14. An operator shall have the ability to backup and restore all BACnet devices on the network.
  15. It shall be each contractor's responsibility to configure each router using the network numbering scheme for the project. Each router shall be configured such that all network layer error messages shall be directed to a specific workstation using the BACnet Confirmed Text Message service. It shall be the contractor's responsibility to initially configure each router with routing tables containing all network numbers that are part of the project's internet. The router shall be able to receive messages at each port of any length that is valid for the LAN technology connected to that port, and to forward the message to any directly-connected network that can convey a message of that size.
  16. Legacy Systems: Bi-directional gateways shall be provided for systems and equipment operating on a legacy/proprietary system. The operator workstation shall display information from both the BACnet and non-BACnet devices. Any information specified or required for system functionality shall be made readable and modifiable. Gateways shall have 10% expansion capacity. Gateways shall support archiving, uploading, trending, scheduling, and alarm/event detection, notification and acknowledgement.
  17. Systems and equipment shall have full 2- way communications and interoperability.
    - a. Exception: Fire safety systems and equipment shall have only read access to outside systems:
      - 1) Fire alarm.
  18. Coordinate with "Instrumentation and Controls for HVAC" and other building operational systems for specific interoperability requirements.
- C. Communications Standard: Coordinate communications standards requirements with other Sections and Divisions.
1. MS/TP LAN: RS 485
  2. Systems with dedicated network(s) shall connect on the BACnet Ethernet LAN: utilizing a switch and shall meet standard Ethernet requirements.
    - a. Utilize RJ-45 terminations.
    - b. Utilize CAT 6 cabling.
    - c. Meet IEEE Standard 802.3 standards and requirements.
    - d. Speed: 100 Mbps.
  3. Equipment without dedicated networks shall connect to the BACnet MS/TP LAN.
    - a. RS 485 communications standard.
    - b. Speed: 1 Mbps.

- D. Information Availability: Make all product information, points, variables, setpoints, etc., available for access of building operational systems upon request.
  - 1. Provide bi-directional point mapping/addressing instructions.
  - 2. Provide on-site technicians as required to ensure proper information exchange.
  
- E. Factory Provided Equipment Controllers: Provide all information, points, variables, setpoints, etc., indicated and referenced in all documentation, including "Instrumentation and Controls for HVAC." Products shall have full interoperability as indicated in this Section, in BACnet standards and elsewhere.

## **PART 2 - PRODUCTS**

### **2.1 SHOP DRAWINGS**

- A. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed or electronic data.
  - 1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.
  
  - 2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

### **2.2 RECORD DRAWINGS**

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
  - 1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an understandable drawing technique.
    - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  
  - 2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Revisions to details shown on Drawings.
    - b. Locations and depths of underground system entities.
    - c. Revisions to routing of piping.
    - d. Actual equipment locations.
    - e. Duct size and routing.
    - f. Locations of concealed internal utilities.
    - g. Changes made by Change Order or Change Directive.
    - h. Changes made following Engineer's written orders.
    - i. Details not on the original Contract Drawings.
    - j. Field records for variable and concealed conditions.
    - k. Record information on the Project scope of work that is shown only schematically.

3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  4. Mark record sets with erasable, colored pencil. Use multiple colors to distinguish between changes for different categories of the Work at same location.
  5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record CAD Drawings: Immediately before observation for Certificate of Substantial Completion, review marked-up Record Prints with Engineer and Construction Manager. When authorized, prepare a full set of corrected CAD Drawings of the Contract Drawings, as follows:
1. Format: Autodesk.dwg format of the same version, and operating system as the original Contract Drawings.
  2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
  3. Refer instances of uncertainty to Engineer for resolution.
  4. Contractor may request one set of CAD Drawings of the Contract Drawings for use in recording information.
    - a. Engineer makes no representations as to the accuracy or completeness of CAD Drawings as they relate to the Contract Drawings.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Record CAD Drawings: Organize information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each file.
  3. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Engineer, Architect and Construction Manager.
    - e. Name of Contractor.

### **2.3 RECORDING AND MAINTENANCE**

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

### **2.4 TRAINING AND INSTRUCTION PROGRAM**

- A. Program Structure: In addition to Division 01 and individual section requirements, develop an instruction program that includes individual training modules for each system and equipment not part of a system.

- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. Provide instruction for the following modules.
1. Basis of System Design and Operational Requirements
  2. Documentation
  3. Emergencies
  4. Adjustments
  5. Troubleshooting
  6. Maintenance
  7. Repairs
- C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

## **2.5 COMPARABLE PRODUCTS**

- A. Conditions for Consideration: Engineer/Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer/Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utility and system connections.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
  3. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Written Report: Where a written report listing conditions detrimental to performance of the Project scope of work is required by other Sections, include the following:
    - a. Description of the Work.
    - b. List of detrimental conditions, including substrates.
    - c. List of unacceptable installation tolerances.



- d. Recommended corrections.
- 2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- 3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
- 4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
- 5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### **3.2 PREPARATION**

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

### **3.3 DEMOLITION**

- A. Work indicated to be removed includes removal of all auxiliary materials, accessories, anchorage, fasteners, and etc., down to bare substrate. No residual materials shall remain from work to be removed. Contractor will use whatever means necessary; including removal of all materials attached or related to those items designated to be removed, as acceptable to Owner and Engineer, to provided complete and thorough removal of existing work.
- B. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.
- D. Abandoned Work: Cut and remove buried MEP system materials, equipment, raceways, piping and distribution, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
- E. Remove demolished materials from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Field verify all existing MEP system materials, equipment, raceways, piping and distribution to be removed for exact quantities.
- H. Remove all existing MEP system materials, equipment, raceways, piping and distribution located above ceilings and in walls that are not being reused.

- I. Remove all MEP systems and appurtenances, which are to be removed, in their entireties back to the source or source panels.
- J. Remove all existing MEP system materials, equipment, raceways, piping and distribution located in walls or ceilings being demolished. Abandon no devices that have been disconnected unless specifically noted.
- K. Maintain continuity of all existing MEP devices, and utilization equipment not removed.
- L. Remove, store, protect, and reinstall existing work as required to accommodate alteration indicated.
- M. The existing work to be removed, in general, is as indicated on the Drawings and in this Section, but also includes any materials or work necessary to permit installation of new materials, as approved by Owner and Engineer.
- N. Disconnect, demolish, and remove systems, equipment, and components indicated to be removed, abandoned or as made obsolete by this project.
  - 1. To Be Removed: Remove portion of systems, equipment, and components indicated to be removed and cap or plug remaining with same or compatible material.
  - 2. To Be Abandoned in Place: Drain piping and cap or plug systems, equipment, and components with same or compatible material.
  - 3. Equipment to Be Removed: Disconnect, make safe and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect, make safe and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect, make safe and cap services and remove equipment and deliver at direction of Owner.
- O. If systems, equipment, and components to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- P. In finished areas, all systems, equipment, and components shall be cut back to a concealed location, i.e., within walls, above ceilings, etc., before capping.

### **3.4 INSTALLATION**

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
  - 4. Maintain minimum headroom clearance as indicated by Architect and/or Construction Manager in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.

- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
  
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
  - 1. All equipment and piping not supported from the building structural steel shall not exceed a combined load of 7 psf when supported from the metal deck/slab. Any condition that may exceed this limit shall be reviewed and approved by the Design-Builder and Structure Engineer before installation.
  - 2. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer and/or to allow for proper access.
  - 3. Allow for building movement, including thermal expansion and contraction.
  - 4. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
  
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### **3.5 CUTTING AND PATCHING**

- A. See Division 01 for additional requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of Work.
  
- B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed, where wall or floors are existing or not correctly located. The Contractor shall do all drilling required for the installation of hangers.
  
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.
  
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### **3.6 SCAFFOLDING, RIGGING, HOISTING**

- A. Excavation and backfilling shall be done per Division 2 of the Specifications.
  
- B. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

### **3.7 EXCAVATION AND BACKFILLING**

- A. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division.

### **3.8 ACCESSIBILITY AND ACCESS PANELS**

- A. The Contractor shall be responsible for and hung ceilings for the proper installation of the Work.
  
- B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Access doors shall be furnished for accessibility. Minor deviations from the Drawings may be made to allow better

accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.

- C. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- D. Access doors in walls, ceilings, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.
- E. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- F. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.

### **3.9 STARTING AND ADJUSTING**

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect field-assembled components and equipment installation, comply with qualification requirements in "Quality Requirements."

### **3.10 PROTECTION OF INSTALLED CONSTRUCTION**

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.
- C. Remove debris from concealed spaces before enclosing the space.
- D. Remove liquid spills promptly.
- E. Where dust would impair proper execution of the Project scope of work, broom-clean or vacuum the entire work area, as appropriate.
- F. Installed Work: Keep installed work clean.
- G. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

**3.11 CORRECTION OF THE WORK**

- A. The cost of corrective work shall be included under the contract.
- B. Repair or remove and replace defective construction.
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- C. Restore permanent facilities used during construction to their specified or original condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components to new condition.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

**END OF SECTION 23 00 10**  
07/10/2018

**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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors and single-phase, fan-duty, horizontal, small and medium, electronically commuted, permanent magnet (EC) motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory.

**1.3 COORDINATION**

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
  - 1. Motor controllers.
  - 2. Torque, speed, and horsepower requirements of the load.
  - 3. Ratings and characteristics of supply circuit and required control sequence.
  - 4. Ambient and environmental conditions of installation location.

**PART 2 - PRODUCTS**

**2.1 GENERAL MOTOR REQUIREMENTS**

- A. Comply with NEMA MG 1 unless otherwise indicated.

**2.2 MOTOR CHARACTERISTICS**

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

**2.3 POLYPHASE MOTORS**

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Energy and premium efficient, as defined in NEMA MG 1.
  - 1. "Energy Efficient" for all motors less than 1 HP.
  - 2. "Premium Efficient" for all motors 1 HP and larger, including those furnished as part of equipment specified in equipment sections. The contractor shall confirm utility company minimum requirements for incentive programs and provide motors with efficiencies that meet or exceed the most stringent between NEMA MG-1 and utility company incentive program requirements. The contractor, at no extra charge to the Owner, shall replace any motor that does not meet the utility company's incentive program. The efficiency and/or "NEMA Premium Efficiency" shall be displayed on the motor nameplate and clearly indicated on the equipment shop drawings submitted for approval.
- C. Service Factor: 1.15.
- D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.
  2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Multispeed Motors: Separate winding for each speed.
- F. Rotor: Random-wound, squirrel cage.
- G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- H. Temperature Rise: Match insulation rating.
- I. Insulation: Class F.
- J. Code Letter Designation:
1. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.
- K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.
- L. Motor Controllers:
1. Motor controllers shall be furnished with the motor and per Division 26.
  2. Overload Protection: Overload protection shall be sized and furnished for the requirements of the specific application.
  3. Accessories: Provide accessories coordinated to the specific application and per Division 26.

#### **2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS**

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.

#### **2.5 SINGLE-PHASE MOTORS**

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
1. Permanent-split capacitor.
  2. Split phase.
  3. Capacitor start, inductor run.
  4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.
- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

#### **2.6 SINGLE-PHASE EC MOTORS**

- A. Motors equal to or smaller than 1 HP shall be Electronically Commuted (EC) type, to suit starting torque and requirements of specific motor applications.
- B. Bearings: Prelubricated, antifriction ball bearings suitable for radial and thrust loading.

- C. Motors: Internal motor circuitry shall convert AC power supplied to the fan to DC power to operate the motor. Motor shall be speed controllable down to 20 percent of full speed (80 percent turndown). Motor shall be a minimum of 85 percent efficient at all speeds.
1. Variable speed, 0 – 2,000 RPM.
  2. Adjustable delay profile.
  3. 0 – 10 volt input signal.
  4. Output signal.
  5. Programmable ramp rate.
  6. Soft start.
  7. Remote controller.
  8. Moisture resistant.
  9. Insulation: Class H.
  10. Enclosure: Class 2, IP44.
  11. Integrated motor protection (electronically protected).
  12. UL 778, 1004-1, 508C.
  13. CAN/CSA C22.2 #108, #100, #107.1.
  14. EMC (89/366 EEC): EN 61000.
  15. LVD (73/23/EC): EN 60335-1, EN 60335-2-51.
  16. Machine Safety (98/37/EC): EN ISO 12100.

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 23 05 13**  
07/10/2018



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**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. Slip-joint packed expansion joints.
  - 2. Expansion-compensator packless expansion joints.
  - 3. Flexible-hose packless expansion joints.
  - 4. Pipe loops and swing connections.
  - 5. Alignment guides and anchors.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, bends, swing connections, anchors and guides.
  - 2. Anchor Details: Locate, size and detail fabrication of each anchor. Show dimensions and methods of assembly and attachment to building structure.
  - 3. Alignment Guide Details: Locate, size and detail field assembly and attachment to building structure for each guide length and maximum spider travel.
  - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.
  - 5. Location of all components on Coordination Drawings.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.
- B. Product Certificates: For each type of expansion joint, from manufacturer.

**1.6 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: For expansion joints to include in maintenance manuals.

**1.7 QUALITY ASSURANCE**

- A. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."

2. ASME Boiler and Pressure Vessel Code: Section IX.

## **PART 2 - PRODUCTS**

### **2.1 PACKED EXPANSION JOINTS**

#### **A. Slip-Joint Packed Expansion Joints:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adscos Manufacturing LLC.
  - b. Advanced Thermal Systems, Inc.
2. Standard: ASTM F 1007.
3. Material: Carbon steel with asbestos-free PTFE packing.
4. Design: With internal guide and injection device for repacking under pressure. Include drip connection if used for steam piping.
5. Configuration: Single joint with base class unless otherwise indicated.
6. End Connections: Flanged or weld ends to match piping system.

### **2.2 PACKLESS EXPANSION JOINTS**

#### **A. Metal, Expansion-Compensator Packless Expansion Joints:**

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adscos Manufacturing LLC.
  - b. Flexicraft Industries.
  - c. Flex-Weld, Inc.
  - d. Metraflex, Inc.
  - e. Senior Flexonics Pathway.
2. Minimum Pressure Rating: 150 psig unless otherwise indicated.
3. Configuration for Copper Tubing: Two-ply, phosphor-bronze bellows with copper pipe ends.
  - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint.
4. Configuration for Steel Piping: Two-ply, stainless-steel bellows; steel-pipe end connections; and carbon-steel shroud.
  - a. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.

#### **B. Flexible-Hose Packless Expansion Joints:**

1. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
  - a. Flex-Hose Co., Inc.
  - b. Flexicraft Industries.
  - c. Flex Pression Ltd.
  - d. Mason Industries, Inc.
  - e. Unisource Manufacturing, Inc.
2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 60-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.

- a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
  - b. Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
5. Expansion Joints for Steel Piping NPS 2 and Smaller: Carbon-steel fittings with threaded end connections.
- a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
  - b. Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.

### **2.3 ALIGNMENT GUIDES AND ANCHORS**

A. Alignment Guides:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Adscos Manufacturing LLC.
  - b. Advanced Thermal Systems, Inc.
  - c. Flexicraft Industries.
  - d. Flex-Weld, Inc.
  - e. Metraflex, Inc.
  - f. Senior Flexonics Pathway.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding spider for bolting to pipe. Determine alignment guide length and maximum spider travel suited for application.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A 36/A 36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel hex head.
3. Washers: ASTM F 844, steel, plain, flat washers.
4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Stud: Threaded, zinc-coated carbon steel.
  - b. Expansion Plug: Zinc-coated steel.
  - c. Washer and Nut: Zinc-coated steel.
5. Chemical Fasteners: Insert-type-stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
  - a. Bonding Material: ASTM C 881/C 881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
  - b. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud unless otherwise indicated.
  - c. Washer and Nut: Zinc-coated steel.

## **PART 3 - EXECUTION**

### **3.1 EXPANSION-JOINT INSTALLATION**

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install packed-type expansion joints with packing suitable for fluid service.

- C. Install rubber packless expansion joints according to FSA-NMEJ-702.

**3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION**

- A. Size and install pipe loops as required to partly absorb tension or compression produced during anticipated change in temperature. Loops and bends shall not be cold spring.
- B. Connect risers and branch connections to mains with at least five pipe fittings including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings including tee in main.

**3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION**

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.
- B. Install two guide(s) on each side of pipe expansion fittings and loops per manufacturer's instructions. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
  - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
  - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24, U-bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
  - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
  - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

**3.4 EXPANSION COMPENSATION APPLICATIONS**

- A. All applications unless noted otherwise. Pipe bend and loops or flexible hose packless expansion joints.
- B. Expansion Compensators: In piping systems 2-1/2 inches and smaller that are installed within enclosures where a pipe bend or loop cannot be applied.
- C. Packed Slip Expansion Joints: In piping system mains that are installed within enclosures where a pipe bend or loop cannot be applied. Single joint up to 12 inches.

**END OF SECTION 23 05 16**  
07/10/2018

**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. Sleeves.
  - 2. Sleeve-seal systems.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

**PART 2 - PRODUCTS**

**2.1 SLEEVES**

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- C. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

**2.2 SLEEVE-SEAL SYSTEMS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Advance Products & Systems, Inc.
  - 2. CALPICO, Inc.
  - 3. Metraflex Company (The).
  - 4. Pipeline Seal and Insulator, Inc.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
  - 1. Sealing Elements: Interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
    - a. EPDM (-40 to 250 Deg F): Standard service applications.
    - b. Nitrite (-40 to 250 Deg F): Hydro carbon service applications.
    - c. Silicon (-67 to 400 Deg F): High temperature or fire seal applications.
  - 2. Pressure Plates: Plastic. Include two for each sealing element.
    - a. Provide steel pressure plates for fire and high temperature applications.
  - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements. Include one for each sealing element.

- a. Provide 316 stainless steel connecting bolts and nuts in corrosive environments where chemicals are present.

**PART 3 - EXECUTION**

**3.1 SLEEVE INSTALLATION**

- A. Install sleeves for piping passing through penetrations in partitions and walls.
- B. Sleeves shall be fastened securely to the assembly that it penetrates.
- C. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough per sleeve seal manufacturer's recommendations to provide minimum 1-inch annular clear space between piping and concrete slabs and walls.
- D. Install sleeves for pipes passing through interior partitions.
  1. Cut sleeves to length for mounting flush with both surfaces.
  2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
  3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Division 07 Section "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors as indicated on architectural drawings at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Division 07 Section "Penetration Firestopping."

**3.2 SLEEVE-SEAL-SYSTEM INSTALLATION**

- A. Install sleeve-seal systems in sleeves in exterior concrete walls at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

**3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE**

- A. Use sleeves and sleeve seals for the following piping-penetration applications:
  1. Exterior Concrete Walls above Grade:
    - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.
  2. Interior Partitions:
    - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

**END OF SECTION 23 05 17**  
07/10/2018

**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. Escutcheons.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

**PART 2 - PRODUCTS**

**2.1 ESCUTCHEONS**

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- D. Split-Casting Brass Type: With polished, chrome-plated and rough-brass finish and with concealed hinge and setscrew.
- E. Split-Plate, Stamped-Steel Type: With chrome-plated finish, concealed hinge, and spring-clip fasteners.

**PART 3 - EXECUTION**

**3.1 INSTALLATION**

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.
- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
  - 1. Escutcheons for New Piping:
    - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
    - b. Chrome-Plated Piping: One-piece, cast-brass type with polished, chrome-plated finish.
    - c. Insulated Piping: One-piece, stamped-steel type.
    - d. Bare Piping at Wall Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
    - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with rough-brass finish.
    - g. Bare Piping in Equipment Rooms: One-piece, cast-brass type with rough-brass finish.



2. Escutcheons for Existing Piping:

- a. Chrome-Plated Piping: Split-casting brass type with polished, chrome-plated finish.
- b. Insulated Piping: Split-plate, stamped-steel type with concealed hinge.
- c. Bare Piping at Wall Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- d. Bare Piping at Ceiling Penetrations in Finished Spaces: Split-casting brass type with polished, chrome-plated finish.
- e. Bare Piping in Unfinished Service Spaces: Split-casting brass type with rough-brass finish.
- f. Bare Piping in Equipment Rooms: Split-casting brass type with rough-brass finish.

**3.2 FIELD QUALITY CONTROL**

- A. Replace broken and damaged escutcheons using new materials.

**END OF SECTION 23 05 18**  
07/10/2018

**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. Bimetallic-actuated thermometers.
  - 2. Thermowells.
  - 3. Dial-type pressure gages.
  - 4. Gage attachments.
  - 5. Test plugs.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Product Certificates: For each type of gage, from manufacturer.
- C. Operation and Maintenance Data: For gages to include in operation and maintenance manuals.

**PART 2 - PRODUCTS**

**2.1 BIMETALLIC-ACTUATED THERMOMETERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ashcroft Inc.
  - 2. Marsh Bellofram.
  - 3. Trerice, H. O. Co.
  - 4. Weiss Instruments, Inc.
  - 5. WIKA Instrument Corporation - USA.
- B. Standard: ASME B40.200.
- C. Case: Liquid-filled and sealed type(s); stainless steel with 5-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- F. Connector Size: 1/2 inch, with ASME B1.1 screw threads.
- G. Stem: 0.25 inch in diameter; stainless steel.
- H. Window: Plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.

- L. Accuracy: Plus or minus 1 percent of scale range.

## **2.2 THERMOWELLS**

- A. Thermowells:

1. Standard: ASME B40.200.
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: Brass.
4. Material for Use with Steel Piping: Stainless steel.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
7. Internal Threads: ASME B1.1 screw threads to match temperature gage.
8. Bore: Diameter required to match thermometer bulb or stem.
9. Insertion Length: Length required to match thermometer bulb or stem.
10. Lagging Extension: Include on thermowells for insulated piping and tubing.
11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

## **2.3 PRESSURE GAGES**

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Ashcroft Inc.
  - b. Marsh Bellofram.
  - c. Trerice, H. O. Co.
  - d. Weiss Instruments, Inc.
  - e. WIKA Instrument Corporation - USA.
2. Standard: ASME B40.100.
3. Case: Sealed type; cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
6. Movement: Mechanical, with link to pressure element and connection to pointer.
7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
8. Pointer: Dark-colored metal.
9. Window: Plastic.
10. Ring: Metal.
11. Accuracy: Grade B, plus or minus 2 percent of middle half of scale range.

## **2.4 GAGE ATTACHMENTS**

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

## **2.5 TEST PLUGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Flow Design, Inc.

2. Peterson Equipment Co., Inc.
3. Trerice, H. O. Co.
4. Watts Regulator Co.; a div. of Watts Water Technologies, Inc.
5. Weiss Instruments, Inc.

- B. Description: Test-station fitting made for insertion into piping tee fitting.
- C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- D. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- E. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- F. Core Inserts: EPDM self-sealing rubber.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install valve and snubber in piping for each pressure gage for fluids.
- H. Install test plugs in piping tees.
- I. Install thermometers in the following locations:
1. Inlet and outlet of each hydronic coil in fan coil units.
- J. Install pressure gages in the following locations:
1. Inlet and outlet of each hydronic coil in fan coil units.

#### **3.2 CONNECTIONS**

- A. Install gages adjacent to machines and equipment to allow service and maintenance of gages, machines, and equipment.

#### **3.3 ADJUSTING**

- A. Adjust faces of gages to proper angle for best visibility.

**3.4 THERMOMETER SCHEDULE**

- A. Thermometers at inlet and outlet of each hydronic coil in fan coil units shall be the following:
  - 1. Liquid-filled or sealed, bimetallic-actuated type.
  - 2. Test plug.

**3.5 THERMOMETER SCALE-RANGE SCHEDULE**

- A. Scale Range for Heating, Hot-Water Piping: 30 to 240 deg F.

**3.6 PRESSURE-GAGE SCHEDULE**

- A. Pressure gages at inlet and outlet of each hydronic coil in fan coil units shall be the following:
  - 1. Sealed, direct mounted.
  - 2. Test plug.

**3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE**

- A. Scale Range for Heating, Hot-Water Piping: 0 to 100 psi.

**END OF SECTION 23 05 19**  
07/10/2018

**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. Brass ball valves.
  - 2. Bronze ball valves.
- B. Related Sections:
  - 1. Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

**1.3 DEFINITIONS**

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. PTFE: Tetrafluoroethylene resin.
- G. RPTFE: Reinforced tetrafluoroethylene resin.
- H. RS: Rising stem.
- I. SWP: Steam working pressure.
- J. VITON: Fluoroelastomer FKM.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of valve indicated.

**1.5 QUALITY ASSURANCE**

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. Source Limitations for Grooved Coupling Installations: Obtain all valves, couplings and fittings from single source from single manufacturer.
- C. ASME Compliance:
  - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
  - 2. ASME B31.1 for power piping valves.
  - 3. ASME B31.9 for building services piping valves.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Prepare valves for shipping as follows:
  - 1. Protect internal parts against rust and corrosion.
  - 2. Protect threads.
  - 3. Set ball valves open to minimize exposure of functional surfaces.
  
- B. Use the following precautions during storage:
  - 1. Maintain valve end protection.
  - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

**PART 2 - PRODUCTS**

**2.1 GENERAL REQUIREMENTS FOR VALVES**

- A. Refer to HVAC valve schedule articles for applications of valves.
  
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
  
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
  
- D. Valve Actuator Types:
  - 1. Handlever: For quarter-turn valves NPS 6 and smaller.
  
- E. Valves in Insulated Piping: With 2-inch stem extensions and the following features:
  - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
  
- F. Valve-End Connections:
  - 1. Solder Joint: With sockets according to ASME B16.18.
  - 2. Threaded: With threads according to ASME B1.20.1.
  
- G. Valve Bypass and Drain Connections: MSS SP-45.

**2.2 BRASS BALL VALVES**

- A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Conbraco Industries, Inc.; Apollo Valves.
    - b. DynaQuip Controls.
    - c. Flow Design.
    - d. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
    - e. Hammond Valve.
    - f. Kitz Corporation.
    - g. Marwin Valve; a division of Richards Industries.
    - h. Milwaukee Valve Company.
    - i. Nexus.
    - j. Red-White Valve Corporation.
    - k. Watts Regulator.

2. Description:
  - a. Standard: MSS SP-110.
  - b. SWP Rating: 150 psig.
  - c. CWP Rating: 600 psig.
  - d. Body Design: Two piece.
  - e. Body Material: Forged brass.
  - f. Ends: Threaded or soldered.
  - g. Seats: PTFE or RPTFE.
  - h. Stem: Brass.
  - i. Ball: Chrome-plated brass.
  - j. Port: Full.
  - k. Packing gland nut or VITON/FPM double-O ring seals.

### 2.3 BRONZE BALL VALVES

- A. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim:
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. American Valve, Inc.
    - b. Conbraco Industries, Inc.; Apollo Valves.
    - c. DynaQuip Controls.
    - d. Hammond Valve.
    - e. Kitz Corporation.
    - f. Legend Valve.
    - g. Milwaukee Valve Company.
    - h. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
  2. Description:
    - a. Standard: MSS SP-110.
    - b. SWP Rating: 150 psig.
    - c. CWP Rating: 600 psig.
    - d. Body Design: Two piece.
    - e. Body Material: Bronze.
    - f. Ends: Threaded or soldered.
    - g. Seats: PTFE or RPTFE.
    - h. Stem: Bronze.
    - i. Ball: Chrome-plated brass.
    - j. Port: Full.
    - k. Packing gland nut or VITON/FPM double O-ring seals.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Do not attempt to repair defective valves; replace with new valves.



**3.2 VALVE INSTALLATION**

- A. Install valves with unions at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

**3.3 ADJUSTING**

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

**3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS**

- A. If valve applications are not indicated, use the following:
  - 1. Shutoff Service: Ball valves.
  - 2. Throttling Service: Ball valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
  - 1. For Steel Piping, NPS 2 and Smaller: Threaded ends.

**3.5 HEATING-WATER VALVE SCHEDULE**

- A. Pipe NPS 2 and Smaller:
  - 1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.
  - 2. Ball Valves: Two piece, full port, brass or bronze with brass trim.

**END OF SECTION 23 05 23**  
07/10/2018

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. This Section includes the following hangers and supports for HVAC system piping and equipment:
  - 1. Steel pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
  - 3. Fastener systems.
- B. Related Sections include the following:
  - 1. Division 23 Section "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
  - 2. Division 23 Section "Metal Ducts" for duct hangers and supports.

**1.3 DEFINITIONS**

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

**1.4 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Steel pipe hangers and supports.
  - 2. Thermal-hanger shield inserts.
  - 3. Powder-actuated fastener systems.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

**2.2 STEEL PIPE HANGERS AND SUPPORTS**

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.
- B. Manufacturers:
  - 1. AAA Technology & Specialties Co., Inc.
  - 2. Anvil, Inc.
  - 3. Bergen-Power Pipe Supports.
  - 4. B-Line Systems, Inc.; a division of Cooper Industries.
  - 5. Carpenter & Paterson, Inc.
  - 6. Empire Industries, Inc.

7. ERICO/Michigan Hanger Co.
8. Globe Pipe Hanger Products, Inc.
9. GS Metals Corp.
10. National Pipe Hanger Corporation.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. Tolco Inc.

- C. Galvanized, Metallic Coatings: Hot dipped after fabrication (ASTM A 123 and ASTM A 153).
- D. Nonmetallic Coatings: Plastic coating, jacket, or liner.
- E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

### **2.3 THERMAL-HANGER SHIELD INSERTS**

- A. Description: 100-psig- minimum, compressive-strength insulation insert encased in sheet metal shield.
- B. Manufacturers:
  1. ERICO/Michigan Hanger Co.
  2. PHS Industries, Inc.
  3. Pipe Shields, Inc.
  4. Rilco Manufacturing Company, Inc.
  5. TOLCO Inc.
  6. Value Engineered Products, Inc.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.
- D. For Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

### **2.4 FASTENER SYSTEMS**

- A. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Verify suitability for use in lightweight concrete slabs and all slabs less than 4 inches thick.
  1. Manufacturers:
    - a. Hilti, Inc.
    - b. ITW Ramset/Red Head.
    - c. Powers Fasteners.
- B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated or stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
  1. Manufacturers:
    - a. Hilti, Inc.
    - b. ITW Ramset/Red Head.

- c. Powers Fasteners.

### **PART 3 - EXECUTION**

#### **3.1 HANGER AND SUPPORT APPLICATIONS**

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with hot dipped galvanized, metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use padded hangers for piping that is subject to scratching.
- F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30.
  - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F pipes, NPS 4 to NPS 16, requiring up to 4 inches of insulation.
  - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24, requiring clamp flexibility and up to 4 inches of insulation.
  - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24, if little or no insulation is required.
  - 5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
  - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8.
  - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8.
  - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2.
  - 10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8.
  - 11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3.
  - 12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30.
  - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20.
  - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20, if longer ends are required for riser clamps.
- H. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
  - 1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
  - 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
  4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
  5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- I. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
  2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
  3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
  4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
  5. C-Clamps (MSS Type 23): For structural shapes.
  6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
  7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
  8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
  9. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
  10. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
  11. Side-Beam Brackets (MSS Type 34): For sides of steel beams.
  12. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
  13. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- J. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Pipe-Covering Protection Saddles (MSS Type 39): For supporting insulated pipe without vapor barrier, fill interior voids with insulation that matches adjoining insulation.
  2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
  3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- K. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction. Verify suitability for use in lightweight concrete slabs and all slabs less than 4 inches thick.

### **3.2 HANGER AND SUPPORT INSTALLATION**

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
- B. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- C. Fastener System Installation:
1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
  2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
  3. Verify suitability of fasteners in lightweight concrete slabs and all concrete slabs less than 4 inches thick.

- D. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- E. Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- F. Install lateral bracing with pipe hangers and supports to prevent swaying.
- G. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- H. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- I. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.
- J. Insulated Piping: Comply with the following:
  - 1. Attach clamps and spacers to piping.
    - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
    - b. Do not exceed pipe stress limits according to ASME B31.1 for power piping and ASME B31.9 for building services piping.
  - 2. Install MSS SP-58, Type 39, galvanized protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
    - a. Option: Thermal-hanger shield inserts may be used.
  - 3. Install MSS SP-58, Type 40, galvanized protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees or per thermal hanger insert manufacturer's recommendations.
    - a. Option: Thermal-hanger shield inserts may be used.
  - 4. Shield Dimensions for Pipe: Not less than the following or per thermal hanger insert manufacturer's recommendations:
    - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
  - 5. Insert Material: Length at least as long as protective shield.
  - 6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

### **3.3 ADJUSTING**

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

**3.4 PAINTING**

- A. Touch Up: Clean abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
  - 1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
  
- B. Galvanized Surfaces: Clean bolted connections and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION 23 05 29**  
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**PART 1 - GENERAL**

**1.1 INTENT**

- A. It is the intent of this Specification to provide the basis of design for the vibration isolation on all HVAC systems. The term "SYSTEMS" applies to all equipment, piping, and ductwork on the project. The following specification provides a requirement for the attachment of all non-structural components to the structure.

**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.

**1.3 SUMMARY**

- A. This Section includes the following:
  - 1. Isolation pads.
  - 2. Elastomeric hangers with vertical limit stops.

**1.4 DEFINITIONS**

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

**1.5 PERFORMANCE REQUIREMENTS**

- A. Comply with seismic requirements in accordance with state and local codes and ordinances and the authority having jurisdiction.
- B. Determine the following, but not limited to, design criteria conditions for the project location required in accordance with all state and local codes and ordinances. Where codes do not reference criteria, refer to the latest "ASHRAE HVAC APPLICATIONS" Handbook. Include criteria with code references in shop drawing submittal.
  - 1. Seismic Loading:
    - a. Site Class as Defined in the IBC: As determined by the seismic engineer.
    - b. Assigned Building Classification Category as Defined in the IBC: III.
      - 1) Component Importance Factor: 1.5 for life safety systems, components with hazardous content and components required for continued operation in Seismic Use Group III structures; 1.0 for all other components.
      - 2) Component Response Modification Factor: As determined by seismic engineer.
      - 3) Component Amplification Factor: As determined by the seismic engineer.
    - c. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.223.
    - d. Design Spectral Response Acceleration at 1-Second Period: 0.065.
    - e. Seismic Design Category: C; seismic bracing of HVAC systems is required only for components with IP = 1.5.



**1.6 SUBMITTALS**

- A. Product Data: For the following:
  - 1. Include detailed type, style, materials, rated load, rated deflection, and overload capacity for each vibration isolation device.
- B. Delegated-Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data.
  - 1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation to select vibration isolators.
- C. Qualification Data: For testing agency.
- D. Material Test Reports: From a qualified testing agency indicating and interpreting test results of seismic control devices for compliance with requirements indicated.
- E. Field quality-control test reports.

**1.7 COORDINATION**

- A. Coordinate size and location of concrete bases with vibration isolation requirements. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of roof curbs and roof penetrations.
- C. Coordinate and design all attachments with building structural system.

**PART 2 - PRODUCTS**

**2.1 VIBRATION ISOLATORS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Kinetics Noise Control.
  - 2. Mason Industries.
  - 3. Vibration Eliminator Co., Inc.
  - 4. Vibration Mountings & Controls, Inc.
- B. Elastomeric Pads: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
  - 1. Resilient Material: Oil- and water-resistant neoprene. Standard neoprene for indoor applications or where pad is not exposed to the elements. Bridge-bearing neoprene, complying with AASHTO M 251 for exterior applications or where pad is exposed to the elements.
- C. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods and vertical limit stop. Color-code or otherwise identify to indicate capacity range.

## 2.2 FACTORY FINISHES

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
  - 1. Powder coating on springs and housings.
  - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
  - 3. Baked enamel or powder coat for metal components on isolators for interior use.
  - 4. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 VIBRATION-CONTROL INSTALLATION

- A. Comply with requirements for installation of roof curbs and roof penetrations.
- B. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- C. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- D. Drilled-in Anchors:
  - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid pre-stressed tendons, electrical and telecommunications conduit, and gas lines.
  - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
  - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
  - 4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
  - 5. Set anchors to manufacturer's recommended torque, using a torque wrench.
  - 6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

### 3.3 EQUIPMENT BASES

- A. Concrete Bases: Anchor equipment to concrete base according to support equipment manufacturer's written instructions for seismic codes at project site.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of the base.
2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and direction furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
6. Cast-in-place concrete materials and placement requirements are specified in Division 3.

**3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Tests and Inspections:
1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  2. Schedule test with Owner, through Architect, before connecting anchorage device to component (unless post-connection testing has been approved), and with at least seven days' advance notice.
  3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  5. Test to 90 percent of rated proof load of device.
  6. Measure isolator restraint clearance.
  7. Measure isolator deflection.
  8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

**3.5 ADJUSTING**

- A. Adjust limit stops on isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- B. Adjust active height of isolators.

**3.6 HVAC VIBRATION-CONTROL DEVICE SCHEDULE**

- A. General: Schedule below indicates type of vibration isolator to be used with types of equipment. All rotating equipment shall have vibration isolation whether listed in schedule or not. Where equipment is not listed, provide isolation type of similar equipment or manufacturer recommended.
- B. Components Mounted on Slab-on-Grade:
1. Ductwork:
    - a. Base: None.
    - b. Isolator Type: None, anchor to structure.
  2. Piping:
    - a. Base: None.
    - b. Isolator Type: None, anchor to structure.

3. Air-Cooled Condensers and Condensing Units, 5 Tons and Less:
    - a. Base: Concrete housekeeping pad.
    - b. Isolator Type: None, anchor to structure.
  4. Make-Up Air Units, Internally Isolated:
    - a. Base: Concrete housekeeping pad.
    - b. Isolator Type: Elastomeric pads, 0.75 inches thick, 1 layer.
  5. Fan Coil Units:
    - a. Base: Concrete housekeeping pad.
    - b. Isolator Type: Elastomeric pads, 0.5 inches thick, 1 layer.
- C. Components hung from overhead structure:
1. Ductwork:
    - a. Isolator Type: None.
  2. Piping:
    - a. Isolator Type: None.
  3. Split System A/C Indoor Units:
    - a. Isolator Type: Elastomeric hangers with vertical limit stop, 0.2 inch deflection.
  4. Unit Heaters and Fan Coil Units:
    - a. Isolator Type: Elastomeric hangers with vertical limit stop, 0.2 inch deflection.
- D. Components Mounted on Roofs:
1. Air-Cooled Condensers and Condensing Units, 5 Tons and Less:
    - a. Base: Equipment support rails.
    - b. Isolator Type: Elastomeric pad, 0.75 inches thick, 1 layer.

**END OF SECTION 23 05 48**  
07/10/2018

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**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. Products specified are for applications referenced in other HVAC specifications.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Equipment labels.
  - 2. Access panel and door labels.
  - 3. Pipe labels.
  - 4. Duct labels.
  - 5. Volume damper location flags.
  - 6. Valve tags.
  - 7. Valve schedules.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label. Furnish extra copies, in addition to mounted copies, for inclusion in maintenance manuals. Provide one copy on electronic media, type specified by Owner.
- D. Valve numbering scheme.
- E. Valve Schedules: Provide separate schedule for each piping system. Furnish extra copies, in addition to mounted copies, for inclusion in maintenance manuals. Provide one copy on electronic media, type specified by Owner.

**1.4 QUALITY ASSURANCE**

- A. ASME Compliance: Comply with ASME A13.1, "Scheme for the Identification of Piping Systems," for letter size, length of color field, colors, and viewing angles of identification devices for piping. Comply with recommendations in ASME A13.1 for labeling of equipment and ducts.

**1.5 COORDINATION**

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.
- D. Coordinate names, abbreviations, and other designations used in mechanical identification with Owner's desired identification scheme, regardless of numbering indicated on the drawing and specifications. Coordinate Owner's desired identification scheme with ASME and OSHA standards.

- E. Coordinate with Owner/Architect, locations of all identifying devices in public view areas.

## **PART 2 - PRODUCTS**

### **2.1 EQUIPMENT LABELS**

- A. Plastic Labels for Equipment:
1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.
  2. Letter Color: White.
  3. Background Color: Blue.
  4. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
  5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
  6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
  7. Fasteners: Stainless-steel rivets or self-tapping screws.
  8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Equipment Label Content: Include equipment's Drawing designation and Owner specified unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

### **2.2 PIPE LABELS**

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction. Color shall comply with ASME A13.1 unless otherwise indicated.
- B. Pretensioned Pipe Markers: Precoiled, semirigid plastic formed to cover circumference of pipe and to attach to pipe without fasteners or adhesive.
1. For Pipes Equal To or Greater Than 6 Inches Outside Diameter with Insulation: Partial cover of circumference with a minimum length and width three times greater than the total lettering size or shaped pipe markers.
  2. For Pipes Less Than 6 Inches Outside Diameter with Insulation: Full cover of circumference.
- C. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
  2. Lettering Size: Manufacturer's standard preprinted captions appropriate for piping systems indicated or 1-1/2 inches high, if requested by Owner.
- D. Use metal labels for bare pipes conveying fluids at temperatures of 125 deg. F or higher.

### **2.3 DUCT LABELS**

- A. General Requirements for Manufactured Duct Labels: Preprinted, color-coded with lettering indicating service and showing flow direction.

- B. Adhesive Duct Markers: Plastic with adhesive backing and peel off covering to attach to pipe without fasteners.
- C. Maximum Temperature: Able to withstand temperatures up to 160 deg. F.
- D. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- E. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
- F. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, duct size, and an arrow indicating flow direction.
  - 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.
  - 2. Quantity of airflow and airflow type (i.e., supply, return, exhaust, outdoor air, etc.).
  - 3. Lettering Size: At least 1-1/2 inches high.

#### **2.4 VALVE TAGS**

- A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers, with numbering scheme approved by Owner.
  - 1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
  - 2. Fasteners: Brass beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
  - 1. Valve-tag schedule shall be included in operation and maintenance data.
  - 2. Valve Schedule Frames: Glazed display frame for removable mounting on masonry walls for each page of valve schedule. Include mounting screws.
  - 3. Frame: Extruded aluminum.
  - 4. Glazing: ASTM C 1036, Class 1, glazing quality B, 2.5 mm, single thickness glass.
- C. Schedule on Electronic Media:
  - 1. In addition to the framed paper schedule, provide valve schedule on electronic media, type specified by Owner, and identified points on as-built drawings.

#### **2.5 VOLUME DAMPER LOCATION FLAGS**

- A. Flags: Yellow one-inch wide tape, minimum 18 inches long.

### **PART 3 - EXECUTION**

#### **3.1 PREPARATION**

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.



**3.2 LABELING COLOR CODING**

- A. Color coding table for ducts, piping and equipment:

System	Background Color	Lettering Color
Heating Hot Water	Orange	Black
Vent / Blowdown	Brown	Yellow
Supply Air	Dark Blue	White
Return Air	Yellow	Black
Exhaust Air (General)	Green	White
Exhaust Air (Kitchen)	Red	White

**3.3 EQUIPMENT LABEL INSTALLATION**

- A. Install or permanently fasten labels on each major item of mechanical equipment. Major equipment includes, but is not limited to, the following:
1. Compressors, condensers, and similar motor-driven units.
  2. Fans and primary balancing dampers.
  3. Packaged HVAC central-station and zone type units.
- B. Locate equipment labels where accessible and visible.
- C. Plastic Label Content: Provide the following equipment information on plastic labels:
1. Capacity, operating and power characteristics (e.g., entering and leaving conditions, speed, pressure drop).
  2. Operating instructions and warnings.
  3. Safety warnings.
  4. Access panels and doors.

**3.4 PIPE LABEL INSTALLATION**

- A. Manufactured Pipe Labels: Provided on all piping.
- B. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces; and exterior exposed locations as follows:
1. Near each valve and control device.
  2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
  3. Near penetrations through walls, ceilings, and inaccessible enclosures.
  4. At access doors and similar access points that permit view of concealed piping.
  5. Near major equipment items and other points of origination and termination.
  6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
- C. Pipe Label Color Schedule: According to ASME 13.1, unless otherwise specified.

**3.5 DUCT LABEL INSTALLATION**

- A. Install self-adhesive duct labels with permanent adhesive on air ducts.
- B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

**3.6 VOLUME DAMPER FLAG INSTALLATION**

- A. Install volume damper flags at each volume damper prior to insulation installation. Flags shall remain visible throughout construction.
- B. Remove flags from ductwork exposed in finished spaces after balancing reports are accepted.

**3.7 VALVE-TAG INSTALLATION**

- A. Install tags on valves and control devices in piping systems, with the following exceptions: check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
  - 1. Valve-Tag Size and Shape: 1-1/2 inches, round.
  - 2. Valve-Tag Color: Natural.
  - 3. Letter Color: Black.

**3.8 VALVE SCHEDULE INSTALLATION**

- A. Mount valve schedule on wall in accessible location in each major equipment room.

**3.9 ADJUSTING**

- A. Relocate mechanical identification materials and devices that have become visually blocked by other work.

**3.10 CLEANING**

- A. Clean faces of mechanical identification devices and glass frames of valve schedules.

**END OF SECTION 23 05 53**  
07/10/2018

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**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. Balancing Air Systems:
    - a. Constant-volume air systems.
  - 2. Balancing Hydronic Piping Systems:
    - a. Constant-flow hydronic systems.

**1.3 DEFINITIONS**

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 45 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.
- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. Sample pressure profile diagrams.
- G. Proposed pressure profile locations.
- H. Instrument calibration reports, to include the following:
  - 1. Instrument type and make.
  - 2. Serial number.
  - 3. Application.
  - 4. Dates of use.

- 5. Dates of calibration.

**1.5 QUALITY ASSURANCE**

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC or NEBB.
  - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC or NEBB.
  - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC or NEBB as a TAB technician.
- B. TAB Conference: Meet with Owner and Construction Manager on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
  - 1. Agenda Items:
    - a. The Contract Documents examination report.
    - b. The TAB plan.
    - c. Coordination and cooperation of trades and subcontractors.
    - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
  - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
  - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

**1.6 PROJECT CONDITIONS**

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

**1.7 COORDINATION**

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

**PART 2 - PRODUCTS (Not Applicable)**

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.

- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine equipment performance data including fan curves.
  - 1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
  - 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- G. Examine test reports specified in individual system and equipment Sections.
- H. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- I. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- J. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- K. Examine operating safety interlocks and controls on HVAC equipment.
- L. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

### **3.2 PREPARATION**

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
  - 1. Permanent electrical-power wiring is complete.
  - 2. Hydronic systems are filled, clean, and free of air.
  - 3. Automatic temperature-control systems are operational.
  - 4. Equipment and duct access doors are securely closed.
  - 5. Balance dampers are open.
  - 6. Isolating and balancing valves are open and control valves are operational.
  - 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
  - 8. Windows and doors can be closed so indicated conditions for system operations can be met.

### **3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING**

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance" or NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and in this Section.

1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
  1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
  2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
  3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," Section 230716 "HVAC Equipment Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Upon successful completion of air and hydronic balancing, measure, record and provide for final reports, pressure profiles of all air and hydronic systems. Pressure profiles shall include, but not be limited to the following:
  1. Air Handling Equipment (FCU's, MAU, Etc.): Pressure measurements across filters, coils, dampers, fans, etc.
  2. Supply Duct Systems: Record operating static pressures at various locations downstream of the fan discharge focusing on any major duct transitions, elbows, change in directions, split flow fittings more than 25% of total upstream flow.
  3. Return Duct Systems: Record operating static pressures at various locations downstream of the fan discharge focusing on any major duct transitions, elbows, change in directions, split flow fittings more than 25% of total downstream flow.
  4. Pressure profiles shall be in diagrammatic format representative of the system and its components and locations where measurements are taken.
- E. Take and report testing and balancing measurements in inch-pound (IP) units.
- F. Replace belts and sheaves as required to meet specified airflows.

### **3.4 PRELIMINARY PROCEDURES - RENOVATION / REMODEL WORK**

- A. In remodel area, a complete preliminary test and balance report shall be accomplished prior to any work. Any obvious deficiencies shall be identified at that time. A complete report of all readings, recommendations, etc., shall be submitted to the Engineer.

### **3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS**

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.

- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.
- K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

### 3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
  - 1. Measure total airflow.
    - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
  - 2. Measure fan static pressures as follows to determine actual static pressure:
    - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
    - b. Measure static pressure directly at the fan outlet or through the flexible connection.
    - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
    - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
  - 3. Measure static pressure across each component that makes up an air-handling unit and other air-handling and -treating equipment.
    - a. Report the cleanliness status of filters and the time static pressures are measured.
  - 4. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
  - 5. Obtain approval from Engineer for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
  - 6. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
  - 1. Measure airflow of submain and branch ducts.
    - a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
  - 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
  - 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.



1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
  2. Adjust patterns of adjustable outlets for proper distribution without drafts.

### **3.7 KITCHEN/SERVICE HOOD EXHAUST SYSTEMS**

A. General Requirements:

1. Balance all rooms to required airflow and/or pressure relationships as noted on the drawings. Document in the test and balance report that all pressure relationships have been set as specified.
2. Determine optimal capture requirements of each hood and adjust systems and flows to match optimal flow.
3. Set, measure and report flows for all hoods.
4. Perform full pitot tube traverses upstream of exhaust fans and balance and report air quantities.
  - a. In welded or mechanical prefabricated high temperature systems, provide air quantities upstream of exhaust fans by summing the flows at all hoods.
5. Measure and report hood capture velocity profiles.

B. Exhaust System:

1. Verify room pressure relationships and report. The testing shall be performed in each room under the following conditions:
  - a. Door closed.
  - b. Door open.
  - c. Thermostat set to its minimum setpoint.
  - d. Thermostat set to its maximum setpoint.
  - e. If the correct pressure relationships cannot be demonstrated, the room shall be retested after the problem has been corrected.
2. Verify hood capture velocities are adequate and report.
3. Verify that the exhaust fans on the roof are operating properly. The fans shall be operating smoothly without surging or vibrating excessively.
4. General Pressure Relationships:
  - a. Dining areas shall be negative to surrounding areas and positive to the outside.
  - b. Cooking areas shall be negative to dining areas and negative to outside.
  - c. Dishwashing and dish collecting areas, where separated, shall be negative to all areas.
5. Measure all egress door static pressures:
  - a. Minimum dP: 0.01" S.P. w.c.
  - b. Maximum dP: 0.15" S.P. w.c.

### **3.8 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS**

- A. Prepare schematic diagrams of systems' "as-built" piping layouts.

- B. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
  - 1. Open all manual valves for maximum flow.
  - 2. Check flow-control valves for specified sequence of operation, and set at indicated flow.
  - 3. Check air vents for a forceful liquid flow exiting from vents when manually operated.

### 3.9 PROCEDURES FOR CONSTANT-FLOW HYDRONIC SYSTEMS

- A. Measure flow at all automatic flow control valves to verify that valves are functioning as designed.
- B. Measure flow at all pressure-independent characterized control valves, with valves in fully open position, to verify that valves are functioning as designed.
- C. Set calibrated balancing valves, if installed, at calculated presettings.
- D. Measure flow at all stations and adjust, where necessary, to obtain first balance.
  - 1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.
- E. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.
- F. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
  - 1. Determine the balancing station with the highest percentage over indicated flow.
  - 2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
  - 3. Record settings and mark balancing devices.
- G. Measure the differential-pressure-control-valve settings existing at the conclusion of balancing.
- H. Check settings and operation of each safety valve. Record settings.

### 3.10 PROCEDURES FOR MOTORS

- A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
  - 1. Manufacturer's name, model number, and serial number.
  - 2. Motor horsepower rating.
  - 3. Motor rpm.
  - 4. Efficiency rating.
  - 5. Nameplate and measured voltage, each phase.
  - 6. Nameplate and measured amperage, each phase.
  - 7. Starter thermal-protection-element rating.

### 3.11 PROCEDURES FOR CONDENSING UNITS

- A. Verify proper rotation of fans.
- B. Measure entering- and leaving-air temperatures.
- C. Record compressor data.

**3.12 PROCEDURES FOR HEAT-TRANSFER COILS**

- A. Measure, adjust, and record the following data for each water coil:
  - 1. Entering- and leaving-water temperature.
  - 2. Water flow rate.
  - 3. Water pressure drop.
  - 4. Dry-bulb temperature of entering and leaving air.
  - 5. Wet-bulb temperature of entering and leaving air for cooling coils.
  - 6. Airflow.
  - 7. Air pressure drop.
  
- B. Measure, adjust, and record the following data for each refrigerant coil:
  - 1. Dry-bulb temperature of entering and leaving air.
  - 2. Wet-bulb temperature of entering and leaving air.
  - 3. Airflow.
  - 4. Air pressure drop.
  - 5. Refrigerant suction pressure and temperature.

**3.13 TOLERANCES**

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
  - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 10 percent.
  - 2. Air Outlets and Inlets: Plus or minus 10 percent.
  - 3. Heating-Water Flow Rate: Plus or minus 10 percent.

**3.14 REPORTING**

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
  
- B. Status Reports: Prepare biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system.

**3.15 FINAL REPORT**

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
  - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
  - 2. Include a list of instruments used for procedures, along with proof of calibration.
  
- B. Final Report Contents: In addition to certified field-report data, include the following:
  - 1. Fan curves.
  - 2. Manufacturers' test data.
  - 3. Field test reports prepared by system and equipment installers.
  - 4. Other information relative to equipment performance; do not include Shop Drawings and product data.

- C. General Report Data: In addition to form titles and entries, include the following data:
1. Title page.
  2. Name and address of the TAB contractor.
  3. Project name.
  4. Project location.
  5. Architect's name and address.
  6. Engineer's name and address.
  7. Contractor's name and address.
  8. Report date.
  9. Signature of TAB supervisor who certifies the report.
  10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
  11. Summary of contents including the following:
    - a. Indicated versus final performance.
    - b. Notable characteristics of systems.
    - c. Description of system operation sequence if it varies from the Contract Documents.
  12. Nomenclature sheets for each item of equipment.
  13. Data for terminal units, including manufacturer's name, type, size, and fittings.
  14. Notes to explain why certain final data in the body of reports vary from indicated values.
  15. Test conditions for fans and pump performance forms including the following:
    - a. Settings for outdoor-, return-, and exhaust-air dampers.
    - b. Conditions of filters.
    - c. Cooling coil, wet- and dry-bulb conditions.
    - d. Fan drive settings including settings and percentage of maximum pitch diameter.
    - e. Settings for supply-air, static-pressure controller.
    - f. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
  2. Water and steam flow rates.
  3. Duct, outlet, and inlet sizes.
  4. Pipe and valve sizes and locations.
  5. Terminal units.
  6. Balancing stations.
  7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
    - a. Unit identification.
    - b. Location.
    - c. Make and type.
    - d. Model number and unit size.
    - e. Manufacturer's serial number.
    - f. Unit arrangement and class.
    - g. Discharge arrangement.
    - h. Sheave make, size in inches, and bore.
    - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
    - j. Number, make, and size of belts.
    - k. Number, type, and size of filters.

2. Motor Data:
  - a. Motor make, and frame type and size.
  - b. Horsepower and rpm.
  - c. Volts, phase, and hertz.
  - d. Full-load amperage and service factor.
  - e. Sheave make, size in inches, and bore.
  - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  
3. Test Data (Indicated and Actual Values):
  - a. Total air flow rate in cfm.
  - b. Total system static pressure in inches wg.
  - c. Fan rpm.
  - d. Discharge static pressure in inches wg.
  - e. Filter static-pressure differential in inches wg.
  - f. Cooling-coil static-pressure differential in inches wg.
  - g. Heating-coil static-pressure differential in inches wg.
  - h. Outdoor airflow in cfm.
  - i. Return airflow in cfm.
  - j. Outdoor-air damper position.
  - k. Return-air damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
  - a. System identification.
  - b. Location.
  - c. Coil type.
  - d. Number of rows.
  - e. Fin spacing in fins per inch o.c.
  - f. Make and model number.
  - g. Face area in sq. ft..
  - h. Tube size in NPS.
  - i. Tube and fin materials.
  - j. Circuiting arrangement.
  
2. Test Data (Indicated and Actual Values):
  - a. Air flow rate in cfm.
  - b. Average face velocity in fpm.
  - c. Air pressure drop in inches wg.
  - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
  - e. Return-air, wet- and dry-bulb temperatures in deg F.
  - f. Entering-air, wet- and dry-bulb temperatures in deg F.
  - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
  - h. Water flow rate in gpm.
  - i. Water pressure differential in feet of head or psig.
  - j. Entering-water temperature in deg F.
  - k. Leaving-water temperature in deg F.
  - l. Refrigerant expansion valve and refrigerant types.
  - m. Refrigerant suction pressure in psig.
  - n. Refrigerant suction temperature in deg F.

G. Gas-Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

1. Unit Data:
  - a. System identification.
  - b. Location.
  - c. Make and type.
  - d. Model number and unit size.
  - e. Manufacturer's serial number.
  - f. Fuel type in input data.
  - g. Output capacity in Btu/h.
  - h. Ignition type.
  - i. Burner-control types.
  - j. Motor horsepower and rpm.
  - k. Motor volts, phase, and hertz.
  - l. Motor full-load amperage and service factor.
  - m. Sheave make, size in inches, and bore.
  - n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  
2. Test Data (Indicated and Actual Values):
  - a. Total air flow rate in cfm.
  - b. Entering-air temperature in deg F.
  - c. Leaving-air temperature in deg F.
  - d. Air temperature differential in deg F.
  - e. Entering-air static pressure in inches wg.
  - f. Leaving-air static pressure in inches wg.
  - g. Air static-pressure differential in inches wg.
  - h. Low-fire fuel input in Btu/h.
  - i. High-fire fuel input in Btu/h.
  - j. Manifold pressure in psig.
  - k. High-temperature-limit setting in deg F.
  - l. Operating set point in Btu/h.
  - m. Motor voltage at each connection.
  - n. Motor amperage for each phase.
  - o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

1. Fan Data:
  - a. System identification.
  - b. Location.
  - c. Make and type.
  - d. Model number and size.
  - e. Manufacturer's serial number.
  - f. Arrangement and class.
  - g. Sheave make, size in inches, and bore.
  - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  
2. Motor Data:
  - a. Motor make, and frame type and size.
  - b. Horsepower and rpm.
  - c. Volts, phase, and hertz.
  - d. Full-load amperage and service factor.
  - e. Sheave make, size in inches, and bore.
  - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
  - g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

- a. Total airflow rate in cfm.
- b. Total system static pressure in inches wg.
- c. Fan rpm.
- d. Discharge static pressure in inches wg.
- e. Suction static pressure in inches wg.

I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

- a. System and air-handling-unit number.
- b. Location and zone.
- c. Traverse air temperature in deg F.
- d. Duct static pressure in inches wg.
- e. Duct size in inches.
- f. Duct area in sq. ft..
- g. Indicated air flow rate in cfm.
- h. Indicated velocity in fpm.
- i. Actual air flow rate in cfm.
- j. Actual average velocity in fpm.
- k. Barometric pressure in psig.

J. Instrument Calibration Reports:

1. Report Data:

- a. Instrument type and make.
- b. Serial number.
- c. Application.
- d. Dates of use.
- e. Dates of calibration.

**3.16 INSPECTIONS**

A. Initial Inspection:

- 1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
- 2. Check the following for each system:
  - a. Measure airflow of at least 10 percent of air outlets.
  - b. Measure water flow of at least 5 percent of terminals.
  - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
  - d. Verify that balancing devices are marked with final balance position.
  - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

- 1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Engineer.
- 2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Engineer.

3. Architect shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
  4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
  5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.
- C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:
1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.
  2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.
- D. Prepare test and inspection reports.

**3.17 ADDITIONAL TESTS**

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

**END OF SECTION 23 05 93**  
07/10/2018



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**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 DEFINITIONS**

- A. Outside Air: Air originating from outside the building, from the primary environment surrounding the building. Outside air includes make-up air, combustion air, fresh air, and other types of air.
- B. Exterior Space: Spaces outside the exterior building envelope that separate conditioned space from the exterior or outside.
- C. Conditioned Space: An enclosed space within a building that is both mechanically heated and mechanically cooled.
- D. Heated Space: An enclosed space within a building that is mechanically heated but not mechanically cooled.
- E. Indirectly Conditioned Space: An enclosed space within a building that is not mechanically heated or cooled, which is heated or cooled by being connected to adjacent spaces. Select examples include spaces above non-insulated ceilings, return air ceiling plenums, unventilated attics with the building envelope insulation at the roof line.
- F. Semi-Heated Space: An enclosed space within a building that is heated and controlled to a temperature maximum of 55 deg. F. Select examples include mechanical rooms, electrical rooms, tunnels.
- G. Unconditioned Space: An enclosed space within a building that is not mechanically cooled or heated and is not indirectly conditioned. Select examples include crawl spaces, storage rooms connecting to the outside, ventilated attics, unventilated attics where the building envelope insulation is located at the ceiling below the attic.
- H. Concealed Ducts/Pipes: Ducts/Pipes not visible within the room where they are located, after project is completed.
- I. Exposed Ducts/Pipes: Ducts/Pipes visible within the room where they are located, after project is completed.
- J. Ceiling Space/Plenum: An enclosed portion of the building structure, other than an occupiable space being conditioned, that is designed to allow air movement, and thereby serve as part of an air distribution system.
- K. Plenum: Part of the duct system connected to diffusers, registers, grilles, louvers for air movement applications.
- L. Moisture Exhaust: Exhaust air that carries a higher than ambient level of moisture/humidity in the stream. Examples include, but are not limited to: shower areas.

**1.3 SUMMARY**

- A. Section includes insulating the following duct services:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Outdoor, exposed supply and return.

B. Related Sections:

1. Section 230716 "HVAC Equipment Insulation."
2. Section 230719 "HVAC Piping Insulation."
3. Section 233113 "Metal Ducts" for duct liners.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
  3. Detail application of field-applied jackets.
  4. Detail application at linkages of control devices.
  5. Submit application schedule indicating each system and barrier provided.
  6. Submit proof of manufacturer's certified installer.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

**1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

**1.8 COORDINATION**

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

**1.9 SCHEDULING**

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.

**PART 2 - PRODUCTS**

**2.1 INSULATION MATERIALS**

- A. Comply with requirements in "Duct Insulation Schedule, General," "Duct and Plenum Blanket Insulation Schedule," and "Duct and Plenum Board Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Minimum Density: 0.75 pcf.
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corporation; SoftTouch Duct Wrap.
    - b. Johns Manville; a Berkshire Hathaway company; Microlite.
    - c. Knauf Insulation; Atmosphere Duct Wrap with ECOSE Technology.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; SOFTR All-Service Duct Wrap.
- F. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Minimum Density: 2.25 pcf.
  - 2. Products: Subject to compliance with requirements, provide one of the following:
    - a. CertainTeed Corporation; Commercial Board.
    - b. Johns Manville; a Berkshire Hathaway company; 800 Series Spin-Glas.
    - c. Knauf Insulation; Earthwool Insulation Board with ECOSE Technology.
    - d. Owens Corning; Fiberglas 700 Series.

**2.2 ADHESIVES**

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products; CP-127.

- b. Eagle Bridges - Marathon Industries; CP-127.Eagle Bridges - Marathon Industries; 225.
  - c. Foster Brand; H. B. Fuller Construction Products; 85-60/85-70.
  - d. Mon-Eco Industries, Inc.; 22-25.
- C. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products; CP-82.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.

### **2.3 MASTICS**

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below ambient services.
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc.; CP-30.
    - b. Foster Brand; H. B. Fuller Construction Products; 30-80/30-90.
    - c. Knauf Insulation; EXPERT Mastics - KI-900 ASJ or EXPERT Mastics - KI-905 ASJ+.
    - d. Vimasco Corporation.
  - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  - 5. Color: White.
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products; CP-10.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products; 46-50.
    - d. Knauf Insulation; EXPERT Mastics - KI-700 ASJ or EXPERT Mastics - KI-705 ASJ+.
    - e. Mon-Eco Industries, Inc.; 55-50.
    - f. Vimasco Corporation; WC-1/WC-5.
  - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
  - 4. Solids Content: 60 percent by volume and 66 percent by weight.
  - 5. Color: White.

### **2.4 SEALANTS**

- A. FSK and Metal Jacket Flashing Sealants:
- 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products; CP-76.
    - b. Eagle Bridges - Marathon Industries; CP-76.Eagle Bridges - Marathon Industries; 405.
    - c. Foster Brand; H. B. Fuller Construction Products; 95-44.
    - d. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

B. ASJ Flashing Sealants and Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products; CP-76.
  - b. Eagle Bridges-Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc.; 30-45, 95-44.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

## 2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
  2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
  3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

## 2.6 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products; Metal Jacketing Systems.
    - b. ITW Insulation Systems; Illinois Tool Works, Inc.; Aluminum and Stainless Steel Jacketing.
    - c. RPR Products, Inc.; Insul-Mate.
  2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Factory cut and rolled to required size.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
    - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.

## 2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.

- b. Compac Corporation; 104 and 105.
  - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
  - d. Knauf Insulation; EXPERT Tapes - ASJ Tape or EXPERT Tapes - ASJ+ Tape.
  - e. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corporation; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    - d. Knauf Insulation; EXPERT Tapes - FSK Tape.
    - e. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - d. Knauf Insulation; EXPERT Tapes - 2 Mil Foil Tape.
    - e. Venture Tape; 3520 CW.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.
  6. Tensile Strength: 34 lbf/inch in width.

## 2.8 SECUREMENTS

- A. Bands:
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Band-It-Idex, Inc.; a unit of Idex Corp.; Band-Fast.
    - b. ITW Insulation Systems; Illinois Tool Works, Inc.; Gerrard Strapping and Seals.
    - c. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
  2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
  3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

**B. Insulation Pins and Hangers:**

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  - a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) AGM Industries, Inc; CHP-1.
    - 2) CL WARD & Family Inc.; CL WARD Weld Pins.
    - 3) Gemco; Cupped Head Weld Pin.
    - 4) Hardcast, Inc.
    - 5) Midwest Fasteners, Inc; Cupped Head.
    - 6) Nelson Stud Welding; CHP.
  
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick, aluminum sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
  - a. Products: Subject to compliance with requirements, provide one of the following:
    - 1) AGM Industries, Inc; RC-150.
    - 2) Gemco; R-150.
    - 3) Hardcast, Inc.
    - 4) Midwest Fasteners, Inc; WA-150.
    - 5) Nelson Stud Welding; Speed Clips.
  
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  1. Verify that systems to be insulated have been tested and are free of defects.
  2. Verify that surfaces to be insulated are clean and dry.
  
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

**3.3 GENERAL INSTALLATION REQUIREMENTS**

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
  
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
  
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
  
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.



- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.
- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
  - 6. Where two layers of insulation are utilized, the vapor barrier may be omitted from the inner layer.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

### **3.4 PENETRATIONS**

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

1. Comply with requirements in Section 078413 "Penetration Firestopping."

### 3.5 INSTALLATION OF MINERAL-FIBER INSULATION

- A. Blanket Insulation Installation on Ducts and Plenums:

1. All Duct Faces: On longitudinal and transverse seams, install butt joint with 2-inch overlapping jacket.
  - a. Do not over-compress insulation during installation.
2. Bottom and Vertical Faces of Ducts 24 Inches and Greater: Install cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. Place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - b. Do not overcompress insulation during installation.
  - c. Impale insulation over pins and attach speed washers.
  - d. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
3. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
  - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
4. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
  - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

- c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not overcompress insulation during installation.
  - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
  - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### **3.6 FIELD-APPLIED JACKET INSTALLATION**

- A. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.
1. Apply jacket directly over bare insulation or insulation with factory-applied jackets. Stagger seams of insulation.
- a. Apply jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  - b. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.
  - c. Angles, channels, or other members shall be aluminum.
  - d. Fasteners shall be aluminum or stainless steel.
  - e. Fabricate jacket so top is center-supported with high point and pitches to prevent ponding of water on top of duct and fittings.
  - f. Caulk jacket seams and joints with suitable weather- and sun-resistant sealant. Apply 6-inch wide "Peel & Seal" seal stick aluminum roll roofing over all caulked seams, joints, supports, and penetrations of jacket.

### **3.7 FINISHES**

- A. Insulation with ASJ or Other Paintable Jacket Material: For exposed ductwork in finished space, paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
- a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- C. Do not field paint aluminum or stainless-steel jackets.

**3.8 DUCT INSULATION SCHEDULE, GENERAL**

- A. Plenums and Ducts Requiring Insulation:
  - 1. Indoor, concealed supply and outdoor air.
  - 2. Indoor, exposed supply and outdoor air.
  - 3. Outdoor, exposed supply and return.
  
- B. Items Not Insulated:
  - 1. Metal ducts with duct liner of sufficient thickness to comply with listed thickness.
  - 2. Factory-insulated flexible ducts.
  - 3. Factory-insulated ducts, plenums and casings.
  - 4. Vibration-control devices.
  - 5. Factory-insulated access panels and doors.
  
- C. General Insulation Schedule:
  - 1. Round and Flat Oval Ductwork: Mineral-fiber blanket unless noted otherwise.
  - 2. Exposed Ductwork: Mineral-fiber board unless noted otherwise.
  - 3. Concealed Ductwork: Mineral-fiber blanket unless noted otherwise.
  - 4. Maximum Conductivity (BTU x in./(hr. x ft<sup>2</sup> x deg. F)) at 75 Deg. F: 0.24.

**3.9 DUCT AND PLENUM BLANKET INSULATION SCHEDULE**

- A. Duct insulation shall be per the following table with minimum thickness number of layers and minimum (R-value) as indicated:

	Conditioned Spaces	Indirectly Conditioned Spaces	Heated, Semi-Heated and Un-conditioned	Exterior
Supply	1"	1.5" (R-6)	3" (R-6)	2-2" (R-12)
Return	None	None	3" (R-6)	2-2" (R-12)
Exhaust	None	None	None	None
Outside Air	2"	1.5"	1"	None

**3.10 DUCT AND PLENUM BOARD INSULATION SCHEDULE**

- A. Duct insulation shall be per the following table with minimum thickness number of layers and minimum (R-value) as indicated.

	Conditioned Spaces	Indirectly Conditioned Spaces	Heated, Semi-Heated and Un-conditioned	Exterior
Supply	1"	1.5" (R-6)	1.5" (R-6)	3" (R-12)
Return	None	None	1.5" (R-6)	3" (R-12)
Exhaust	None	None	None	None
Outside Air	2"	1.5"	1"	None

**3.11 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

- B. Ducts and Plenums, Concealed:
  - 1. None.
  
- C. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
  - 1. Aluminum, Smooth: 0.024 inch thick.
  
- D. Ducts and Plenums, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
  - 1. Aluminum, Smooth: 0.032 inch thick.

**END OF SECTION 23 07 13**  
07/10/2018

**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 DEFINITIONS**

- A. Conditioned Space: An enclosed space within a building that is both mechanically heated and mechanically cooled.
- B. Heated Space: An enclosed space within a building that is mechanical heated but not mechanically cooled.
- C. Indirectly Conditioned Space: An enclosed space within a building that is not mechanically heated or cooled, which is heated or cooled by being connected to adjacent spaces. Select examples include spaces above non-insulated ceilings, return air ceiling plenums, unventilated attic with the building envelope insulation at the roof line.
- D. Semi-Heated Space: An enclosed space within a building that is heated and controlled to a temperature maximum of 55 deg. F. Select examples include mechanical rooms, electrical rooms, tunnels.
- E. Unconditioned Space: An enclosed space within a building that is not mechanically cooled or heated and is not indirectly conditioned. Select examples include crawl spaces, storage rooms connecting to the outside, ventilated attics, unventilated attics where the building envelope insulation is located at the ceiling below the attic.
- F. Concealed Ducts/Pipes: Ducts/Pipes not visible within the room they are located, after the project is completed.
- G. Exposed Ducts/Pipes: Ducts/Pipes visible within the room they are located, after the project is completed.
- H. Ceiling Space/Plenum: An enclosed portion of the building structure, other than an occupiable space being conditioned, that is designed to allow air movement, and thereby serve as part of an air distribution system.

**1.3 SUMMARY**

- A. Section includes insulating the following HVAC piping systems:
  - 1. Heating hot-water piping, indoors.
  - 2. Refrigerant suction and hot-gas piping, indoors and outdoors.
- B. Related Sections:
  - 1. Section 230713 "Duct Insulation."
  - 2. Section 230716 "HVAC Equipment Insulation."

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail insulation application at pipe expansion joints for each type of insulation.
3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
4. Detail removable insulation at piping specialties.
5. Detail application of field-applied jackets.
6. Detail application at linkages of control devices.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

#### **1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
  1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  2. Insulation Installed Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

#### **1.7 DELIVERY, STORAGE, AND HANDLING**

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

#### **1.8 COORDINATION**

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

#### **1.9 SCHEDULING**

- A. Schedule insulation application after pressure testing systems. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

**PART 2 - PRODUCTS**

**2.1 INSULATION MATERIALS**

- A. Comply with requirements in "Piping Insulation Schedule, General," and "Conditioned Space, Heated, Semi-Heated and Indirectly Conditioned Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- D. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- E. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA, Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. K-Flex USA; Insul-Lock, Insul-Tube.
- F. Mineral-Fiber, Preformed Pipe Insulation:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Johns Manville; a Berkshire Hathaway company; Micro-Lok.
    - b. Knauf Insulation; Earthwool 1000 Degree Pipe Insulation with ECOSE Technology or Earthwool Redi-Klad 1000 Degree Pipe Insulation with ECOSE Technology.
    - c. Owens Corning; Fiberglas Pipe Insulation or SSL II.
  - 2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, minimum of 3.5 pounds per cubic foot density with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, minimum 3.5 pounds per cubic foot density with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

**2.2 ADHESIVES**

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
- B. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Aeroflex USA, Inc.; Aero seal.
    - b. Armacell LLC; Armaflex 520 Adhesive.
    - c. Foster Brand; H.B. Fuller Construction Products; 85-75.
    - d. K-Flex USA; K-Flex 320 Contact Adhesive, K-Flex 373 Contact Adhesive.
- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.



1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products; CP-127.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products; 85-60/85-70.
  - d. Mon-Eco Industries, Inc.; 22-25.
  
- D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products; CP-82.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products; 85-50.
    - d. Mon-Eco Industries, Inc.; 22-25.
  
- E. PVC Jacket Adhesive: Compatible with PVC jacket.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Dow Corning Corporation; DOW CORNING® 739 PLASTIC ADHESIVE.
    - b. Johns Manville; a Berkshire Hathaway company; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
    - d. Speedline Corporation; Polyco VP Adhesive.

### **2.3 MASTICS**

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
  
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand, Specialty Construction Brands, Inc.; CP-30.
    - b. Foster Brand; H. B. Fuller Construction Products; 30-80/30-90.
    - c. Knauf Insulation; EXPERT Mastics - KI-900 ASJ or EXPERT Mastics - KI-905 ASJ+.
    - d. Vimasco Corporation.
  
  2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.
  4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
  5. Color: White.
  
- C. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
  1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Childers Brand; H. B. Fuller Construction Products; CP-10.
    - b. Eagle Bridges - Marathon Industries.
    - c. Foster Brand; H. B. Fuller Construction Products; 46-50.
    - d. Knauf Insulation; EXPERT Mastics - KI-700 ASJ or EXPERT Mastics - KI-705 ASJ+.
    - e. Mon-Eco Industries, Inc.; 55-50.
    - f. Vimasco Corporation; WC-1/WC-5.
  
  2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180 deg F.

4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

## **2.4 SEALANTS**

### **A. FSK and Metal Jacket Flashing Sealants:**

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products; CP-76.
  - b. Eagle Bridges - Marathon Industries.
  - c. Foster Brand; H. B. Fuller Construction Products; 95-44.
  - d. Mon-Eco Industries, Inc.; 44-05.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.

### **B. ASJ Flashing Sealants and PVC Jacket Flashing Sealants:**

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products; CP-76.
  - b. Eagle Bridges-Marathon Industries; 405.
  - c. Foster Brand, Specialty Construction Brands, Inc.; 30-45, 95-44.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.

## **2.5 FACTORY-APPLIED JACKETS**

### **A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:**

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

## **2.6 FIELD-APPLIED JACKETS**

### **A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.**

### **B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; 25/50 flame-spread/smoke developed rating; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.**

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Johns Manville; a Berkshire Hathaway company; Zeston 300 Series.
  - b. P.I.C. Plastics, Inc.; FG Series.
  - c. Proto Corporation; LoSmoke.
  - d. Speedline Corporation; SmokeSafe.
2. Flame Spread: 25.
3. Smoke Developed: 50.

4. Adhesive: As recommended by jacket material manufacturer.
5. Color: Color-code jackets based on system.
6. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
  - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:
  - a. Childers Brand; H. B. Fuller Construction Products; Metal Jacketing Systems.
  - b. ITW Insulation Systems; Illinois Tool Works, Inc.; Aluminum and Stainless Steel Jacketing.
  - c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
  - a. Factory cut and rolled to required size.
  - b. Finish and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
  - e. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
  - a. Factory cut and rolled to required size.
  - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
  - c. Moisture Barrier for Indoor Applications: 1-mil- thick, heat-bonded polyethylene and kraft paper.
  - d. Moisture Barrier for Outdoor Applications: 3-mil- thick, heat-bonded polyethylene and kraft paper.
  - e. Factory-Fabricated Fitting Covers:
    - 1) Same material, finish, and thickness as jacket.
    - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
    - 3) Tee covers.
    - 4) Flange and union covers.
    - 5) End caps.
    - 6) Beveled collars.
    - 7) Valve covers.
    - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

**2.7 TAPES**

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
    - b. Compac Corporation; 104 and 105.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ, Ideal Tape 428 ASJ or Ideal Tape Cold Seal 728 ASJ.
    - d. Knauf Insulation; EXPERT Tapes - ASJ Tape or EXPERT Tapes - ASJ+ Tape.
    - e. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corporation; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK, Ideal Tape 491 FSK or Ideal Tape Cold Seal 791 FSK.
    - d. Knauf Insulation; EXPERT Tapes - FSK Tape.
    - e. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Compac Corporation.
    - b. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    - c. Venture Tape; 1506 CW NS.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide one of the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corporation.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF, Ideal Tape 288 AWF' Ideal Tape 488 AWF Ideal Tape 488 ECO, Ideal Tape 488S AWF, Ideal Tape Cold Seal 788S, or Ideal Tape Ideal Seal 490.
    - d. Knauf Insulation; EXPERT Tapes - 2 Mil Foil Tape.

- e. Venture Tape; 3520 CW.
  - 2. Width: 2 inches.
  - 3. Thickness: 3.7 mils.
  - 4. Adhesion: 100 ounces force/inch in width.
  - 5. Elongation: 5 percent.
  - 6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.; Saran 540 Vapor Retarder Tape.
      - 2. Width: 3 inches.
      - 3. Film Thickness: 4 mils.
      - 4. Adhesive Thickness: 1.5 mils.
      - 5. Elongation at Break: 145 percent.
      - 6. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.
  - 1. Products: Subject to compliance with requirements, provide the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.; Saran 560 Vapor Retarder Tape.
      - 2. Width: 3 inches.
      - 3. Film Thickness: 6 mils.
      - 4. Adhesive Thickness: 1.5 mils.
      - 5. Elongation at Break: 145 percent.
      - 6. Tensile Strength: 55 lbf/inch in width.

## **2.8 SECUREMENTS**

- A. Bands:
  - 1. Products: Subject to compliance with requirements, provide one of the following:
    - a. ITW Insulation Systems; Illinois Tool Works, Inc.; Gerrard Strapping and Seals.
    - b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.
  - 2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 3/4 inch wide with wing seal or closed seal.
  - 3. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
  - 1. Verify that systems to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

**3.3 GENERAL INSTALLATION REQUIREMENTS**

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.
  - 2. Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive.
  - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. .
    - a. For below-ambient services, apply vapor-barrier mastic per manufacturer's recommendations.
  - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
  - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
  - 1. Vibration-control devices.
  - 2. Testing agency labels and stamps.
  - 3. Nameplates and data plates.
  - 4. Manholes.
  - 5. Handholes.
  - 6. Cleanouts.

### **3.4 PENETRATIONS**

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  - 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
  - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistant joint sealers.

### **3.5 GENERAL PIPE INSULATION INSTALLATION**

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
  - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece

- and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
  9. Label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
  2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
  3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
  4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
  5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### **3.6 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION**

- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.



B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### **3.7 INSTALLATION OF MINERAL-FIBER INSULATION**

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

**3.8 FIELD-APPLIED JACKET INSTALLATION**

- A. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications. Seal with manufacturer's recommended adhesive.
  1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- B. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

**3.9 FINISHES**

- A. Pipe Insulation with ASJ or Other Paintable Jacket Material for Exposed Piping in Finished Spaces: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
  1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

**3.10 PIPING INSULATION SCHEDULE, GENERAL**

- A. Acceptable preformed pipe insulation materials and thicknesses are identified for each piping system and pipe size range.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  1. Chrome-plated pipes and fittings unless there is a potential for personnel injury.
- C. Service Drains and Vents: Insulation and jacketing to be the same as for the piping system served.

**3.11 CONDITIONED SPACE, HEATED, SEMI-HEATED, AND INDIRECTLY CONDITIONED PIPING INSULATION SCHEDULE**

- A. Mineral-Fiber (unless otherwise noted), Preformed Pipe, Type I, Minimum Resistance: R = 3.7/in.:

Service	Temp. Deg. F	1" and Less	1" to 1.25"	1.5" to 3"
Refrigerant (Flexible Elastomeric)	<60	0.5	0.5	1.0
Hot Water	105-200	1.5	1.5	2

**3.12 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE**

- A. Mineral-Fiber (unless otherwise noted), Preformed Pipe, Type I, Minimum Resistance: R = 3.7/in.:

Service	Temp. Deg. F	1" and Less	1" to 1.25"	1.5" to 3"
Refrigerant (Flexible Elastomeric)	<60	0.5	0.5	1.0

**3.13 INDOOR, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
1. None.
- D. Piping, Exposed:
1. In Unfinished and Mechanical Spaces: PVC, color-coded by system, 20 mils thick.

- a. Color Coding Table:

System	Color
Heating Hot Water	Orange

2. In General Finished Areas: PVC, white, 20 mils thick.
3. Stainless Steel, Type 304, Smooth 2B Finish: 0.024 inch thick with sealed joints in food handling areas.

**3.14 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE**

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. Piping, Exposed:
1. Aluminum, Stucco Embossed: 0.032 inch thick.

**END OF SECTION 23 07 19**  
07/10/2018

**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. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.
- B. Acceptable Manufacturers; Basis of Design – Subject to compliance with requirements, all controllers and workstation software shall be manufactured by the Enfield Armory's standardized manufacturer: "Johnson Controls, Inc. – Metasys Extended Architecture System." Contact Chris Schoonerman at (860) 604-2014 for more information.
- C. All new work will tie into the existing Johnson Controls Server located in Hartford Armory's Facilities Office over the government certified network. Graphics on the server will be updated with new HVAC systems on this project.
- D. All new HVAC controls must seamlessly integrate into the Johnson Controls network based system.
- E. This Section includes the following items for wiring systems used as signal pathways for high-speed data transmission:
  - 1. Mounting elements.
  - 2. Unshielded twisted-pair cabling.
  - 3. Fiber-optic cabling.
- F. Identification products, related sections include the following:
  - 1. Division 23 Section "Gages for HVAC Piping" for measuring equipment that relates to this Section.
  - 2. Division 23 Section "Sequence of Operations" for requirements that relate to this Section.
- G. Work in this Section includes:
  - 1. A complete system including power and control wiring of all control system components and devices. This system is to be an extension of the existing JCI system.
  - 2. Wiring circuits which are activated/de-activated by a control system component, such as but not limited to, high and low limit protective devices, relays, end switches, etc.
  - 3. Control panel wiring to control panels (unless noted otherwise) and to terminal strips, and field wiring from terminal strips to field-mounted devices.
  - 4. Wiring to the "auto" side of hand-off-auto switches on units being controlled by the controls contractor.
  - 5. Wiring of all electro-mechanical devices required to be located on or in temperature control panels.
  - 6. Power and control wiring to all control system equipment including, but not limited to, control panels, motorized dampers and valve actuators, control transformers, time clocks, relays, transformers, remote switches, and all other control devices. Provide power wiring from electrical panel circuit breakers. Circuit breakers provided under Division 26 Section "Panelboards." Coordinate requirements with the Division 26 Contractor.
  - 7. Control equipment and devices that are provided with a voltage rating readily available at the location of installation. Coordinate with Contract Documents and Division 26 Contractor.
  - 8. Wiring between components of packaged equipment.
  - 9. Provision and wiring of all remote manual control devices, including but not limited to, on/off switches, on/off switches with pilot lights, manual time switches, etc.

10. Interlock wiring from a fire alarm system interface device and/or duct-mounted smoke detector relay contact to unit control circuit for system shutdown, including all necessary control relays and devices rated for voltages and amperages involved. Coordinate with Division 28 Section "Digital, Addressable Fire Alarm System."
  11. Interlock wiring from a fire alarm system interface device to unit control circuit for system emergency shutdown, including all necessary control relays and devices rated for voltages and amperages involved. Coordinate with Division 28 Section "Digital, Addressable Fire Alarm System."
  12. All line voltage wiring and conduit. Comply with the requirements of Division 26 Section "Wires and Cables." A licensed electrician shall perform all work in strict accordance with the NEC and other local codes.
  13. All control wiring and cable. A licensed electrician shall perform all work in strict accordance with the NEC and other local codes.
  14. Integration with balancing work to provide support and calibration.
  15. Alternate wall mounted device locations as selected by the Architect and/or Engineer up to 15 feet from locations shown on plans.
  16. Ethernet devices, hardware and coordination as required to access LAN and Internet.
- H. Work By Others: The following work shall be performed by the associated division contractor under the supervision and coordination of this subcontractor.
1. Division 23 Sections "Hydronic Piping" contractor shall be responsible for:
    - a. Installation of all line size and non-line size automatic valves and separable wells furnished under this contract.
    - b. Furnish and install all necessary valved pressure taps, water and drain wells and overflow connections to piping.
    - c. Furnish and install all necessary piping connections required for flow indicating devices.
  2. Division 23 Section "Metal Ducts" contractor shall be responsible for:
    - a. Install all control dampers and provide safing as required to install non-duct size dampers.
    - b. Assemble multiple section dampers with required interconnecting linkages and extend the required number of shafts through the ducts of externally mounted damper motors.
    - c. Provide and locate sheet metal baffle plates in ductwork, units, mixing boxes, plenums, etc., as required to eliminate stratification. Affix baffles permanently in place after stratification problem has been eliminated.
    - d. Provide access doors or other approved means of access through ducts for service to control equipment.
    - e. Install all duct smoke detectors as furnished under Division 28.
  3. Division 26 contract shall be responsible for:
    - a. Furnishing, installing and terminating all feeder and/or branch circuit wiring to major equipment including:
      - 1) Wiring to and between all disconnects, starters, and equipment motors.
    - b. Furnishing and installing of circuit breakers (20 A-1 phase) in power panels for use by the ATCS Contractor to power the ATCS.
    - c. Furnishing duct smoke detectors specified under Division 28. The installation of the detectors shall be under Division 23 Section "Metal Ducts" and as supervised by this Contractor. The Division 26 Contractor shall furnish and install all wiring between the detector and the fire alarm system.

### **1.3 DEFINITIONS**

- A. Backbone: A facility (e.g., pathway, cable, or conductors) between automation system cabinets or between buildings.

- B. BICSI: Building Industry Consulting Service International.
- C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- D. DDC: Direct digital control.
- E. EMI: Electromagnetic interference.
- F. Horizontal Cabling: Cabling between, and including, the building automation system outlet or the first mechanical terminations on the horizontal connection point and the horizontal cross-connect.
- G. IDC: Insulation displacement connector.
- H. I/O: Input/output.
- I. LAN: Local area network.
- J. MS/TP: Master slave/token passing.
- K. PC: Personal computer.
- L. PID: Proportional plus integral plus derivative.
- M. RCDD: Registered Communications Distribution Designer.
- N. RMC: Rigid metallic conduit.
- O. RTD: Resistance temperature detector.
- P. UTP: Unshielded twisted pair.

#### 1.4 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
  - 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
  - 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
  - 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
  - 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
  - 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within five seconds of each other.
  - 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
  - 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
  - 8. Reporting Accuracy: The system shall report all values with an end to end minimum accuracy as follows:
    - a. Water Temperature: Plus or minus 1 deg F.

- b. Water Flow: Plus or minus 5 percent of full scale.
  - c. Water Pressure: Plus or minus 2 percent of full scale.
  - d. Space Temperature: Plus or minus 1 deg F.
  - e. Ducted Air Temperature: Plus or minus 1 deg F.
  - f. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
9. Stability and Accuracy of Control: Control loops shall maintain measured variable at setpoint within the following minimum tolerances:
- a. Liquid Pressure (Greater Than 1 psig): Plus or minus 1.5 psig.
  - b. Liquid Pressure (Less Than 50 Inch wg): Plus or minus 1.0 inch wg.
  - c. Air Pressure (0-6 Inch wg Range): Plus or minus 0.2.
  - d. Air Pressure (0.01-0.1 Inch wg Range): Plus or minus 0.0.1 inch wg.
  - e. Plus or minus 10% of full range.
  - f. Plus or minus 2 deg F.
  - g. Duct Temperature: Plus or minus 3 deg F.

### **1.5 COMMON REQUIREMENTS FOR SEQUENCES OF OPERATION**

- A. The following items are common requirements that apply unless noted otherwise:
- 1. All setpoints shall be program adjustable at the existing remote operator workstation.
  - 2. All high and low limits shall be alarmed.
  - 3. All horizontal fan coil units cooling coils shall have a condensate pan high level alarm.
  - 4. All hydronic proof of flow shall be via current sensors.
  - 5. All fan proof of operation shall be by high and low current sensors.
  - 6. All unit smoke detection, freeze protection, high condensate level and other emergency shutdown shall be done by hardwired relay interlock and shall not rely on control system programming.
  - 7. All dampers shall have open and close status indication through end switches or integral actuator feature.
  - 8. All dampers shall have an independent control point. Multiple dampers of different applications (i.e., outdoor, return) controlled from a single point are not acceptable.
  - 9. All air handling systems with ducted outdoor air shall be provided with freeze protection.

### **1.6 SUBMITTALS**

- A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
- 1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
  - 2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
  - 3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.
  - 2. Schematic flow diagrams showing fans, coils, dampers, valves, and control devices.
  - 3. Wiring Diagrams: Power, signal, and control wiring.
  - 4. Details of control panel faces, including controls, instruments, and labeling.
  - 5. Written description of sequence of operation.
  - 6. Schedule of dampers including size, leakage, and flow characteristics.

7. Schedule of valves including flow characteristics.
  8. DDC System Hardware:
    - a. Wiring diagrams for control units with termination numbers.
    - b. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between existing remote operator workstation and control unit locations.
  9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, operator notations, and a graphics tree showing how graphics are organized and linked.
  10. Controlled Systems:
    - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    - c. Written description of sequence of operation including schematic diagram.
    - d. Points list.
- C. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.
- D. Samples for Initial Selection: For each color required, of each type of thermostat or sensor cover with factory-applied color finishes.
- E. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
  2. Program Software Backup: On a magnetic media or compact disc, complete with data files.
  3. Device address list.
  4. Printout of software application and graphic screens.
  5. Software license required by and installed for DDC workstations and control systems.
- F. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.
- G. Qualification Data: For Installer and manufacturer.
- H. Field quality-control test reports.
- I. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
1. Maintenance instructions and lists of spare parts for each type of control device.
  2. Interconnection wiring diagrams with identified and numbered system components and devices.
  3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
  4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
  5. Calibration records and list of set points.
  6. An electronic copy of all graphics, programming and settings in final as-built form on a CD-ROM.
- J. Project Record Drawings: These shall be as-built versions of the submittal shop drawings. One set of magnetic media including CAD, .DWG, or .DXF drawing files also shall be provided.
- K. Testing and Checklists: Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3 "Demonstration and Acceptance."



**1.7 QUALITY ASSURANCE**

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Installer Qualifications: Cabling installer must have on staff personnel certified by BICSI.
  - 1. Installation Supervision: Installation shall be under the direct supervision of a Registered Technician, who shall be present at all times when Work of this Section is performed at the project site.
- C. Electrical Installer: Line voltage wiring for the automatic control system shall be done by a Licensed Electrician.
- D. 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 intended use.
- E. Comply with ASHRAE 135 for DDC system components.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.
- B. System Software: Update to latest version of software at Project completion.

**1.9 COORDINATION**

- A. Coordinate and confirm location of thermostats and other exposed control sensors with Architect and/or Engineer and plans and room details before installation.
- B. Coordinate equipment with Division 28 Section "Digital, Addressable Fire-Alarm System" to achieve compatibility with equipment that interfaces with that system, including power/control voltage ratings and control sequence requirements.
- C. Coordinate supply of electrical branch circuits for control units.
- D. Coordinate equipment with Division 26 Section "Panelboards" to achieve compatibility with starter coils and annunciation devices.
- E. Coordinate equipment with Division 26 Sections "Enclosed Controllers" to achieve compatibility with controllers and annunciation devices.
- F. Coordinate support of balancing requirements and system component calibration requirements with Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

**1.10 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Additional Points: Provide a minimum of 10% spare point hardware capacity in each controller and panel of each point type; analog and digital, input and output powered and dry.
  - 2. Replacement Materials: 5%, but no less than 2 of each type of wall mounted sensor (thermostats, temperature sensors, etc.).

**1.11 LICENSING**

- A. Software: Owner has full license of use of all software programming, including the right to change and edit programming to suit needs.
- B. Protocols: Owner has full license to all system and networking protocols.
- C. Points: Owner has full license to all system points to change, modify or otherwise alter to suit needs.

**1.12 TRAINING**

- A. Provide one day of training on site.
- B. The BAS Contractor shall provide instructors to give full instructions to designated personnel in the adjustment, operation, and maintenance of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 am to 4:30 pm weekdays.
- C. Training shall include, but not be limited to, the following:
  - 1. Explanation of drawings and operations and maintenance manuals.
  - 2. Walk-through of the job to locate control components.
  - 3. DDC controller and TEC operation.
  - 4. Explanation of adjustment, calibration, and replacement procedures.
- D. Training of the Owner's operation and maintenance personnel is required in cooperation with the Owner's representative. Provide competent, factory authorized personnel to provide instruction to operation and maintenance personnel concerning the location, operation, and troubleshooting of the installed systems. The instruction shall be scheduled in coordination with the Construction Manager after submission and approval of formal training plans.

**PART 2 - PRODUCTS**

**2.1 COMMUNICATION AND ARCHITECTURE**

- A. All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to ANSI/ASHRAE Standard 135-1995, BACnet.
- B. Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this Section.
- C. The Contractor shall provide all communication media, connectors, repeaters, hubs, and routers necessary for the internetwork.
- D. All controllers shall have a communication port for connections with the operator interfaces using the BACnet Data Link/Physical layer protocol.
- E. Remote operator interface shall be via web-based server software for remote operator interface using the BACnet PTP Data Link/Physical layer protocol. Remote operator interface via this software shall allow for communication with any and all controllers on this network as described below.

- F. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
1. Connection of an operator interface device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
  2. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing.
- G. The time clocks in all controllers shall be automatically synchronized daily via the internetwork. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the internetwork.
- H. The internetwork shall have the following minimum capacity for future expansion:
1. Each building controller shall have routing capacity for 50 controllers.
  2. The building controller network shall have capacity for 50 building controllers.
  3. The system shall have an overall capacity for 12,500 building controllers, custom application controller, and application specific controller input/output objects.
- I. Building Controllers: Provide an adequate number of building controllers to achieve the performance specified in Part 1 article on "System Performance." Each of these panels shall meet the following requirements:
1. The Building Automation System (BAS) shall be composed of one or more independent, standalone, microprocessor-based building controllers to manage the global strategies of the system.
  2. The building controller shall have sufficient memory to support its operating system, database, trending, and programming requirements.
  3. Data shall be shared between networked building controllers.
  4. The operating system of the building controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
  5. Each building controller shall reside on a BACnet network using the ISO 8802-3 (Ethernet) Data Link/Physical layer protocol. Each building controller also shall perform BACnet routing to a network of custom application and application specific controllers.
- J. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, power and control wiring, and accessories to control mechanical systems.

## **2.2 DDC EQUIPMENT**

- A. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.
1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to existing remote operator workstation.
  2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.

- d. Software applications, scheduling, and alarm processing.
  - e. Testing and developing control algorithms without disrupting field hardware and controlled environment.
3. Standard Application Programs:
- a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.
  - b. HVAC Control Programs: Optimal run time.
  - c. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.
  - d. Remote communications.
  - e. Maintenance management.
  - f. Units of Measure: Inch-pound.
4. Local operator interface provides for download from or upload to existing remote operator workstation.
5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- B. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.
- 1. Units monitor or control each I/O point, process information, and download from or upload to existing remote operator workstation.
  - 2. Stand-alone mode control functions operate regardless of network status. Functions include the following:
    - a. Global communications.
    - b. Discrete/digital, analog, and pulse I/O.
    - c. Monitoring, controlling, or addressing data points.
  - 3. Local operator interface provides for download from or upload to existing remote operator workstation.
  - 4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.
- C. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
- 1. Binary Inputs: Allow monitoring of on-off signals without external power.
  - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
  - 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
  - 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation.
  - 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
  - 6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.
  - 7. Universal I/Os: Provide software selectable binary or analog outputs.
- D. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
- 1. Output ripple of 5.0 mV maximum peak to peak.

2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.
  3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- E. Power Line Filtering: Internal or external transient voltage and surge suppression for controllers with the following:
1. Minimum dielectric strength of 1000 V.
  2. Maximum response time of 10 nanoseconds.
  3. Minimum transverse-mode noise attenuation of 65 dB.
  4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

### **2.3 UNITARY CONTROLLERS**

- A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.
1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.
  2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.
  3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.
  4. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

### **2.4 INPUT DEVICES**

- A. General Requirements:
1. Installation, testing, and calibration of all sensors, transmitters, and other input devices shall be provided to meet the system requirements.
- B. Temperature Sensors:
1. Manufacturers:
    - a. Primary controls manufacturer.
  2. General Requirements:
    - a. The temperature sensor shall be of the resistance type and shall be 2-wire 1000 ohm RTD.
  3. Room Temperature Sensors for Hot Water Baseboard Radiation/Convactor:
    - a. Room sensor shall be wall plate, brushed stainless steel, either surface or wall box mounting.
  4. Room Temperature Sensors for Fan Coil Units:
    - a. Room sensors shall be constructed for either surface or wall box mounting.
    - b. Room sensors shall have the following options:
      - 1) Setpoint reset slide switch providing a +/-3 degrees (adjustable) range.

- 2) A momentary override request pushbutton for activation of after-hours operation.
5. Room Temperature Sensor for Make-Up Air Units:
    - a. Room sensor shall be constructed for either surface or wall box mounting.
    - b. Room sensor shall have an integral LCD display and a four button keypad with the following capabilities:
      - 1) Display room air temperature.
      - 2) Display and adjust room comfort setpoint.
      - 3) Timed override request pushbutton with LED status for activation of after-hours operation.
      - 4) Display controller mode.
  6. Thermo Wells:
    - a. Thermo wells shall be pressure-rated and constructed in accordance with the system working pressure.
    - b. Thermo wells and sensors shall be mounted in a threadolet or 1/2" NPT saddle and allow easy access to the sensor for repair or replacement.
  7. Duct Mount Sensors:
    - a. Duct mount sensors shall mount in an electrical box through a hole in the duct, and be positioned so as to be easily accessible for repair or replacement.
    - b. Duct sensors shall be insertion type and constructed as a complete assembly, including lock nut and mounting plate.
    - c. For outdoor air duct applications, a weatherproof mounting box with weatherproof cover and gasket shall be used.
  8. Averaging Sensors:
    - a. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
    - b. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of four sensing points per 12 ft. long segment.
    - c. Capillary supports at the sides of the duct shall be provided to support the sensing string.
- C. Differential Pressure Transmitters/Transducers:
1. Manufacturers:
    - a. Ashcroft, Inc.
    - b. MAMAC Systems, Inc.
    - c. Setra Systems, Inc.
    - d. Veris Industries.
  2. General Air Pressure Transmitter Requirements:
    - a. Pressure transmitters shall be constructed to withstand 100% pressure over-range without damage, and to hold calibrated accuracy when subject to a momentary 40% over-range input.
    - b. Pressure transmitters shall transmit a 0 to 5 VDC, 0 to 10 VDC, or 4 to 20 mA output signal.
    - c. Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device.
    - d. A minimum of a NEMA 1 housing shall be provided for the transmitter. Transmitters shall be located in accessible local control panels wherever possible.

3. Low Differential Air Pressure Applications (0" to 5" w.c.):
  - a. The differential pressure transmitter shall be of industrial quality and transmit a linear, 4 to 20 mA output in response to variation of differential pressure or air pressure sensing points.
  - b. The differential pressure transmitter shall have non-interactive zero and span adjustments that are adjustable from the outside cover and meet the following performance specifications:
    - 1) 0.00 - 1.00" to 5.00" w.c. input differential pressure ranges (select range appropriate for system application).
    - 2) 4-20 mA output.
    - 3) Maintain accuracy up to 20 to 1 ratio turndown.
    - 4) Reference Accuracy: +0.2% of full span.

**D. Status and Safety Switches:**

1. General Requirements:
  - a. Switches shall be provided to monitor equipment status, safety conditions, and generate alarms at the BMS when a failure or abnormal condition occurs. Safety switches shall be provided with two sets of contacts and shall be interlock wired to shut down respective equipment.
2. Current Sensing Switches:
  - a. Manufacturers:
    - 1) Schneider Electric.
    - 2) Setra Systems, Inc.
    - 3) Veris Industries.
  - b. The current sensing switch shall be self-powered with solid-state circuitry and a dry contact output. It shall consist of a current transformer, a solid state current sensing circuit, adjustable trip point, solid-state switch, SPDT relay, and an LED indicating the on or off status. A conductor of the load shall be passed through the window of the device. It shall accept over-current up to twice its trip point range.
  - c. Current sensing switches shall be used for run status for fans, pumps, and other miscellaneous motor loads.
  - d. Current sensing switches shall be calibrated to show a positive run status only when the motor is operating under load. A motor running with a broken belt or coupling shall indicate a negative run status.
3. Air Filter Status Switches:
  - a. Differential pressure switches used to monitor air filter status shall be of the automatic reset type with SPDT contacts rated for 2 amps at 120 Vac.
  - b. A complete installation kit shall be provided, including static pressure tops, tubing, fittings, and air filters.
  - c. Provide appropriate scale range and differential adjustment for intended service.
4. Air Flow Switches:
  - a. Differential pressure flow switches shall be bellows actuated mercury switches or snap acting micro-switches with appropriate scale range and differential adjustment for intended service.

5. Air Pressure Safety Switches:
  - a. Air pressure safety switches shall be of the manual reset type with SPDT contacts rated for 2 amps at 120 Vac.
  - b. Pressure range shall be adjustable with appropriate scale range and differential adjustment for intended service.
  
6. Low Temperature Limit (Freeze) Switches:
  - a. The low temperature limit switch shall be of the manual reset type with double pole/single throw snap acting contacts rated for 16 amps at 120 Vac.
  - b. The sensing element shall be a minimum of 15 feet in length and shall react to the coldest 18-inch section. Element shall be mounted horizontally across duct in accordance with manufacturer's recommended installation procedures.
  - c. For large duct areas where the sensing element does not provide full coverage of the air stream, additional switches shall be provided as required to provide full protection of the air stream.

## **2.5 MISCELLANEOUS DEVICES**

### **A. Local Control Panels:**

1. All control panels shall be factory constructed, incorporating the BAS manufacturer's standard designs and layouts. All control panels shall be UL inspected and listed as an assembly and carry a UL 508 label listing compliance. Control panels shall be fully enclosed, with perforated sub-panel, hinged door and slotted flush latch.
2. In general, the control panels shall consist of the DDC controller(s), display module as specified and indicated on the plans, and I/O devices such as relays, transducers, and so forth that are not required to be located external to the control panel due to function. Where specified the display module shall be flush-mounted in the panel face unless otherwise noted.
3. All I/O connections on the DDC controller shall be provided via removable or fixed screw terminals.
4. Low and line voltage wiring shall be segregated. All provided terminal strips and wiring shall be UL listed, 300 volt service and provide adequate clearance for field wiring.
5. All wiring shall be neatly installed in plastic trays or tie-wrapped.
6. A convenience 120 Vac duplex receptacle shall be provided in each enclosure, fused on/off power switch, and required transformers.

### **B. Power Supplies:**

1. DC power supplies shall be sized for the connected device load. Total rated load shall not exceed 75% of the rated capacity of the power supply.
2. Input: 120 Vac +10%, 60 Hz.
3. Output: 24 Vdc.
4. Line Regulation: +0.05% for 10% line change.
5. Load Regulation: +0.05% for 50% load change.
6. Ripple and Noise: 1 mV rms, 5 mV peak to peak.
7. An appropriately sized fuse and fuse block shall be provided and located next to the power supply.
8. A power disconnect switch shall be provided next to the power supply.

## **2.6 SNAP SWITCHES**

- A. Comply with NEMA WD1 and UL20.



B. Pilot Light Switches, 20 A:

1. Basis-of-Design product: Subject to compliance requirements, provide Hubbell or comparable product by one of the following:
  - a. Cooper; 222PL for 120 V and 277 V.
  - b. Hubbell; HPL1221PL for 120 V and 277 V.
  - c. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
  - d. Pass & Seymour; PS20AC1-PLR for 120 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON".

**2.7 ACTUATORS**

A. Manufacturers:

1. Match DDC control system manufacturer.
2. Belimo Aircontrols (USA), Inc.
3. Danaher Motion, Thompson.
4. NEP, Inc.; Neptronic.

B. Electronic Damper Actuators:

1. Size for torque required for damper seal at load conditions.
2. Coupling: V-bolt dual nut clamp with a V-shaped, toothed cradle.
3. Paralleling: Mechanically and electrically paralleled to increase torque as required.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to prevent any damage to the actuator during a stall condition.
5. Fail-Safe Operation: Mechanical, spring-return mechanism or internal capacitors.
6. Power Requirements (Two-Position): 24 Vac.
7. Power Requirements (Proportional): Maximum 10 VA at 24 Vac or 8 W at 24 Vdc.
8. Proportional actuators shall be fully programmable. Control input, position feedback and running time shall be factory or field programmable by use of external computer software. Diagnostic feedback shall provide indications of hunting or oscillation, mechanical overload and mechanical travel. Programming shall be through an EEPROM without the use of actuator mounted switches.
9. Temperature Rating: -22 to +122 deg F.
10. Housing: Minimum requirement NEMA Type 2 / IP54 mounted in any orientation.
11. Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.

C. Electronic Valve Actuators:

1. Size for torque required for valve close off at 150% of total system (head) pressure for two-way valves; and 100% of pressure differential across the valve or 100% of total system (pump) head differential pressure for 3-way valves.
2. Coupling: Directly couple end mount to stem, shaft, or ISO-style direct-coupled mounting pad.
3. Paralleling: Mechanically and electrically paralleled to increase torque as required.
4. Overload Protection: Electronic overload or digital rotation-sensing circuitry without the use of end switches to deactivate the actuator at the end of rotation.
5. Fail-Safe Operation: Mechanical, spring-return mechanism or internal capacitors.
6. Power Requirements: Maximum 10 VA at 24 Vac or 8 W at 24 Vdc.
7. Maximum 1 VA at 24 Vac or 1 W at 24 Vdc.
8. Temperature Rating: -22 to +122 deg F.
9. Housing: Minimum requirement NEMA Type 2 / IP54 mounted in any orientation.
10. Agency Listing: ISO 9001, cULus, and CSA C22.2 No. 24-93.

## 2.8 CONTROL VALVES

- A. Manufacturers:
1. Match DDC control system manufacturer.
  2. Belimo Aircontrols (USA), Inc.
  3. NEP, Inc.; Neptronic.
- B. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
- C. Select control valves, except wafer types, with the following end connections:
1. For Piping, NPS 2 and Smaller: Threaded ends.
- D. Characterized Control Valves:
1. NPS 3 and Smaller: Nickel-plated forged brass body rated at no less than 400 psi, stainless steel ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-ring packing design, fiberglass reinforced Teflon seats, and a TEFZEL flow characterizing disc.
  2. NPS 3/4" and Smaller: Nickel-plated forged brass body rated at no less than 600 psi, chrome-plated brass ball and blowout proof stem, female NPT end fittings, with a dual EPDM O-Ring packing design, fiberglass reinforced Teflon seats.
- E. Sizing for Hydronic Valves:
1. Two-Position: Line size or size using a pressure differential of 1 psi.
  2. Two-Way Modulating: 5 psig or twice the load pressure drop, whichever is more.
- F. Hydronic System Pressure Independent Control Valves:
1. NPS 2 and Smaller: Forged brass body rated at 400 psi, chrome-plated brass ball and stem, female NPT union ends, dual EPDM lubricated O-rings and a brass or TEFZEL characterizing disc.
  2. Accuracy: The control valves shall accurately control the flow from 0 to 100% full rated flow with an operating pressure differential range of 5 to 50 psi differential across the valve with a valve body accuracy of +/-5% variance due to differential pressure fluctuation, manufacturing tolerances and valve hysteresis.
  3. Flow Characteristics: Equal percentage characteristics.
- G. Two-Position (On/Off) Valves:
1. NPS 1 and Smaller: Forged brass body rated at no less than 300 psi, stainless steel stem, female, NPT union or sweat with a stainless steel stem and EPDM seals.
  2. Sizing:
    - a. Two-Position: Line size or size using a pressure differential of 1 psi.
  3. Close-Off Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150% of total system head pressure for 2-way valves and 125% of the design pressure differential across the 3-way valves.
  4. The actuator shall be the same manufacturer as the valve, integrally mounted to the valve at the factory.
- H. Pre-Piped Coil Connection Kits:
1. Supply Side Components: Isolation ball valve, manual air vent, strainer, drain, pressure independent control valve, P/T port, stainless or bronze braided flexible hose, union fitting.

2. Return Side Components: Union fitting with a P/T port, stainless or bronze braided flexible hose, isolation ball valve, manual air vent, P/T port.
3. Refer to documents for additional information on components and component arrangement.
4. Component Integration: Valving components can be integrated into multi-function devices except for the control valve.
5. Flexible Hose Length: 24" minimum; 48" maximum.

## **2.9 DAMPERS**

### **A. Manufacturers:**

1. Air Balance Inc.
2. Ruskin Company.
3. TAMCO (T. A. Morrison & Co. Inc.).
4. United Enertech Corp.
5. Vent Products Company, Inc.

### **B. Ratings:**

1. Leakage: Damper shall have a maximum leakage of 10 cfm/sq. ft. at 1" w.g. for a 12" wide damper and shall be AMCA licensed as Class 1A.
2. Differential Pressure: Damper shall have a maximum differential pressure rating of 13" w.g. for a 12" blade.
3. Velocity: Damper shall have a maximum velocity rating of 6,000 fpm.
4. Temperature: Damper shall be rated for 250 deg F.

### **C. Construction:**

1. Frame: 5 inches x minimum 16 gage roll formed, galvanized steel hat-shaped channel, reinforced at corners. Structurally equivalent to 13 gage U-channel.
2. Blades:
  - a. Style: Airfoil-shaped, single-piece.
  - b. Action for Two Position Dampers: Parallel.
  - c. Action for Modulating Dampers: Opposed.
  - d. Orientation: Horizontal.
  - e. Material: Minimum 16 gage equivalent thickness, galvanized steel.
  - f. Width: Nominal 6 inches.
3. Bearings: Self-lubricating stainless steel sleeve, turning in extruded hole in frame.
4. Seals:
  - a. Blade: Extruded neoprene type for ultra-low leakage from 250 deg F. Mechanically attached to blade edge.
  - b. Jamb: Flexible metal compression type.
5. Linkage: In frame.
6. Axles: Minimum 1/2 inch diameter plated steel, hex-shaped, mechanically attached to blade.
7. Finish: Mill galvanized.

## **2.10 DAMPER ACCESSORIES**

### **A. End Switch Package:**

1. Two-position indicator switches linked directly to damper blade to remotely indicate damper blade position.

### **B. Flange Frame: Minimum 6 inches x 1-3/8 inches x 0.125 inch aluminum, bolt holes in corners.**

1. Mates To: TDC, TDF, Ductmate, Nexus, Ward, and other T-flange duct connections.
2. Performance: Maximum free area and lowest pressure drop.

C. Factory Sleeve: Minimum 20 gage thickness, minimum 12 inches length.

D. Duct Transition Connection: Round, oval or rectangular to match duct connections.

## 2.11 UNSHIELDED TWISTED-PAIR CABLING

A. Cable Manufacturers:

1. Avaya Inc.
2. Belden Inc.; Electronics Division.
3. CommScope Properties, LLC.
4. General Cable Technologies Corporation.
5. Helix/HiTemp Cables, Inc.
6. KRONE Incorporated.
7. Mohawk/CDT; a division of Cable Design Technologies.
8. Nordex/CDT; a Subsidiary of Cable Design Technologies.
9. Remeo Products Corp.
10. Superior Essex; Superior Telecommunications Inc.
11. West Penn Wire/CDT; a division of Cable Design Technologies.

B. Terminal and Connector Component Manufacturers:

1. AMP; a Tyco International Ltd. Company.
2. Amphenol Corporation.
3. Avaya Inc.
4. Connect-Tech Products.
5. Cooper Wiring Devices; a division of Cooper Industries, Inc.
6. Homaco.
7. Hubbell Premise Wiring.
8. KRONE Incorporated.
9. Leviton Voice & Data Division.
10. Lucent Technologies; Global Service Provider.
11. Mohawk/CDT; a division of Cable Design Technologies.
12. Molex Premise Networks; a division of Molex, Incorporated.
13. Nordex/CDT; a Subsidiary of Cable Design Technologies.
14. Panduit Corp.
15. Thomas & Betts Corporation.

C. 100-Ohm UTP: Comply with UL 444.

D. Backbone Copper Cable:

1. No. 24 AWG.
2. Comply with ICEA S-80-576 and TIA/EIA-568 B.2, Categories 5e and 6.
3. NFPA 70, Type CMR complying with UL 1666.
4. Cable Jacket Color: Blue.

E. Horizontal Copper Cable:

1. No. 24 AWG, 100 ohm, four pair.
2. Comply with TIA/EIA-568-B.2, Categories 5e and 6.
3. NFPA 70, Types CMG and CMP.
4. Cable Jacket Color: Blue.

- F. Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, using modules designed for punch-down caps or tools.
  - 1. IDC Terminal Block Modules: Integral with connector bodies, including plugs and jackets where indicated.
  - 2. IDC Connecting Hardware: Consistent throughout Project.
- G. Patch Panel: Comply with TIA/EIA-568-B.2, meeting or exceeding cable performance. Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
  - 1. Number of Jacks per Field: One for each four-pair conductor group of indicated cables, plus spares and blank positions adequate to satisfy specified expansion criteria.
- H. Jack and Jack Assemblies: Modular, color-coded, RJ-45 receptacle units with integral IDC-type terminals. Use keyed jacks for data service.
- I. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with RJ-45 plug at each end. Use keyed plugs for data service.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION STANDARDS**

- A. Comply with BICSI TCI, TIA/EIA-568-B.1, TIA/EIA-568-B.2, TIA/EIA-568-B.3, and TIA/EIA-569-A.

#### **3.2 TAB SUPPORT**

- A. Pre-TAB Meeting: Approximately 2 weeks prior to the initiation of Division 23 "Testing, Adjusting and Balancing for HVAC" services on site, schedule a meeting giving notice to the Construction Manager, Architect and Engineer and facilities representative(s).
  - 1. Publish an agenda with a minimum of the following discussion items:
    - a. "Instrumentation and Controls for HVAC" sequence of upcoming construction.
    - b. "Testing, Adjusting and Balancing for HVAC" sequence of upcoming construction.
    - c. TAB for support from "Instrumentation and Controls for HVAC."
    - d. "Instrumentation and Controls for HVAC" requirements for support from TAB.
    - e. Timing, support and documentation procedures.
    - f. Operation, diversities and setpoints of systems and equipment.
- B. Division 23 "Testing, Adjusting and Balancing for HVAC" shall fully support Division 23 "Instrumentation and Controls for HVAC" in the testing and calibration of all devices with fluid flow, motor transformers, static pressures and the like and shall coordinate work so as to not interfere with instrumentation and controls installation and setup activities.
- C. Division 23 "Instrumentation and Controls for HVAC" shall fully support Division 23 "Testing, Adjusting and Balancing for HVAC" in the operation, start and stop of all systems as well as the setting of values required for proper balancing and shall coordinate work so as to not interfere with TAB activities.

#### **3.3 EXAMINATION**

- A. Verify that power supply is available for control units.
- B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

- C. Examine pathway elements intended for cables.
  - 1. Verify proposed routes of pathways. Check raceways, cable trays, and other elements for compliance with space allocations, clearances, installation tolerances, hazards to cable installation, and other conditions affecting installation. Verify that cabling can be installed complying with EMI clearance requirements.
  - 2. Prepare wall penetrations and verify that penetrations of rated fire walls are made using products labeled for type of wall penetrated.
  - 3. Identify plan to support cables and raceways in suspended ceilings. Verify weight of individual types and sizes of cables. Verify that load capacity of cable support structures is adequate for each pathway.
  - 4. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.4 INSTALLATION**

- A. Install software in control units and existing remote operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.
- B. Connect and configure equipment and software to achieve sequence of operation specified.
- C. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.
  - 1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- D. Install automatic dampers according to Division 23 Section "Air Duct Accessories."
- E. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.
- F. Install labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- G. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
- H. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."
- I. Pre-Piped Coil Connection Kits:
  - 1. Pressure independent control valves may be provided as part of a pre-manufactured pipe package at coil connections for piping specified at NPS 1-1/4" and smaller only where concealed from view above accessible ceiling construction.
- J. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

### **3.5 APPLICATION OF MEDIA**

- A. Backbone Cable for Data Service: Use UTP Category 6 for runs between cabinets.
- B. Horizontal Cable for Data Service: Use UTP Category 5e cable for runs between cabinets and peripheral equipment.

**3.6 ELECTRICAL WIRING AND CONNECTION INSTALLATION**

- A. Comply with NECA 1.
- B. Wiring Method: Install wiring and optical fiber in raceway within the following areas: mechanical rooms, electrical rooms, exposed areas, within walls and above inaccessible ceilings. Conceal raceway except in mechanical rooms and areas where other raceway and piping are exposed.
- C. Cable Installation:
  - 1. Install exposed cables parallel and perpendicular to surfaces or exposed structural members and follow surface contours where possible.
  - 2. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 3. Pulling Cable: Do not exceed manufacturer's written recommended pulling tensions. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 4. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 6. Install UTP cables using techniques, practices, and methods that are consistent with Category 5e or 6 rating of components and that ensure Category 5e or 6 performance of completed and linked signal paths, end to end.
    - a. Do not untwist more than 1/2 inch of Categories 5e and 6 cables at connector terminations.
- D. Separation from EMI Sources: Comply with BICSI TDM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment. Comply with the following minimum separation distances from possible sources of EMI:
  - 1. Separation between unshielded power lines or electrical equipment in proximity to open cables or cables in nonmetallic raceways is as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: 5 inches.
    - b. Electrical Equipment Rating Between 2 and 5 kVA: 12 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: 24 inches.
  - 2. Separation between unshielded power lines or electrical equipment in proximity to cables in grounded metallic raceways is as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: 2-1/2 inches.
    - b. Electrical Equipment Rating Between 2 and 5 kVA: 6 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: 12 inches.
  - 3. Separation between power lines and electrical equipment located in grounded metallic conduits or enclosures in proximity to cables in grounded metallic raceways is as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating Between 2 and 5 kVA: 3 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: 6 inches.
  - 4. Electrical Motors and Transformers, 5 kVA or HP and Larger: 48 inches.
  - 5. Fluorescent Fixtures: 5 inches.

- E. Conduit:
  - 1. Comply with TIA/EIA-569-A for maximum length of conduit and bends between pull points, and for pull-box sizing.
  - 2. Use manufactured conduit sweeps and long-radius ells whenever possible.
  - 3. In mechanical rooms, position conduit ends adjacent to a corner on backboard (in case of a single piece of plywood) or in the corner of room (where multiple sheets of plywood are installed around perimeter walls of room). Use cable trays to route cables if conduits cannot be located in these positions. Secure conduits to backboard when entering room from overhead. Extend conduits 1 to 3 inches in finished floor.
  - 4. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
  - 5. Install exposed cable in raceway.
  - 6. Install concealed cable in raceway.
  - 7. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
  - 8. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
  - 9. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
  - 10. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
  
- F. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."
  
- G. Connect manual-reset limit controls independent of manual-control switch positions.
  
- H. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

### **3.7 GROUNDING**

- A. Comply with Division 26 Section "Grounding and Bonding for Electrical Systems" and with TIA/EIA 607.
  
- B. Grounding Points:
  - 1. Locate grounding terminals in each equipment room, wiring closet, rack, and cabinet.
  - 2. Telecommunications Grounding Busbars: Mount on wall of equipment room and closet, with standoff insulators.
  
- C. Bonding Conductors:
  - 1. Extend from telecommunications entrance facility to grounding busbars.
  - 2. Extend from grounding busbars to ground terminals in cabinets.
  
- D. Special Requirements:
  - 1. Bonding conductors shall be insulated copper, No. 6 AWG minimum.
  - 2. Install only in nonmetallic conduit, unless specifically required for protection of conductor. Metallic conduit, if used, shall be RMC. For RMC that exceeds 36 inches in length, conductors shall be bonded at each end of conduit.
  - 3. Bonding conductors shall be installed without splices unless approved by Architect because of special circumstances. Where splices are necessary, they shall be accessible and shall be located in telecommunications spaces. Splices shall be by irreversible compression connectors or by exothermic welding.



**3.8 CONTROL AND MONITORING NETWORK**

- A. Connect to remote central control and monitoring systems. Provide all hardware, software, protocols and cabling required for a complete interface.
- B. All interface, alarms, graphics, system control, editing, and other functionalities of this system shall be fully operable at the remote head end system.
- C. Confirm restrictions and requirements with Owner for any IT backbone, standards, interfacing, etc.

**3.9 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
  - 2. Test and adjust controls and safeties.
  - 3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
  - 4. Test each point through its full operating range to verify that safety and operating control set points are as required.
  - 5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
  - 6. Test each system for compliance with sequence of operation.
  - 7. Test software and hardware interlocks.
- C. DDC Verification:
  - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
  - 2. Check instruments for proper location and accessibility.
  - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
  - 4. Check temperature instruments and material and length of sensing elements.
  - 5. Check control valves. Verify that they are in correct direction.
  - 6. Check DDC system as follows:
    - a. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    - b. Verify that spare I/O capacity has been provided.
    - c. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.
- E. In addition to requirements in this Article, comply with TIA/EIA-606-A and with applicable requirements in Division 26 Section "Identification for Electrical Systems."
  - 1. Administration class for this Project shall be Class 2 or 3.
  - 2. Color-code cross-connect fields. Apply colors to service backboards, connections, covers, and labels.
- F. Using cable and asset management software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable, and label cable, jacks, connectors, and terminals to which it connects with same designation. Use logical

and systematic designations for facility's architectural arrangement. At completion, cable and asset management software shall reflect as-built conditions.

- G. Use logical and systematic designations for facility's architectural arrangement and nomenclature, and a consistent color-coded identification of individual conductors.
- H. Cable and Wire Identification:
  - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Label each terminal strip and screw terminal in each cabinet.
    - a. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    - b. Label each unit and field within distribution racks and frames.
- I. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

### **3.10 GRAPHICS ORGANIZATION**

- A. General:
  - 1. Graphics shall be full color with motion utilizing floor plans wherever possible to indicate location of applicable information and fully accessible through the web-based software.
  - 2. A general color scheme shall be utilized to indicate status of equipment and information.
    - a. BLUE: Equipment/system normal, off; point normal.
    - b. GREEN: Equipment/system normal, on.
    - c. YELLOW: Equipment/system alarm, operating; point minor alarm.
    - d. RED: Equipment failure; point major alarm.
    - e. PURPLE: Operator override.
  - 3. Provide the following links in a block in the same general location on every graphic:
    - a. Primary graphic.
    - b. All screens associated with the current graphic.
    - c. As-Built Sequence of Operation
    - d. Back to previous.
    - e. Forward to next.
  - 4. Organize graphics in easily understandable levels to minimize search time for desired information.
    - a. There shall be at least 2 levels and no more than 4 levels.
    - b. Smaller systems can have one primary graphic with links to all other graphics.
    - c. Larger systems can be organized with one primary graphic, a secondary set of categorized graphics to organize like specific graphics (i.e., zones, air systems, chilled water systems, hot water systems, etc.), then a third layer to take the user to specific graphics.
- B. Primary Graphic:
  - 1. The primary graphic will show well organized links to all other graphic levels with short descriptive labels.
  - 2. Import the Owner's logo and clearly show the project name.

C. Zone Graphics:

1. Provide floor plan based graphics to show zones. Organize in a similar fashion to Contract Drawings and provide a sufficient scale so all information is easily readable and understandable.
2. Provide links to all other zone graphics.
3. Provide links to all individual zone terminal equipment.
4. Show all zone terminal equipment information with blocks in the associated zone. Each block shall change color to indicate normal/alarm modes.

D. System Graphics:

1. Each discreet system shall have a single graphic organized in schematic form accurately representing the installation configuration.
2. Each system or piece of equipment that has been provided with 2-way communications such as through an RS 485 connection shall be provided with a dedicated graphic regardless of which contract it was provided under or if it was Owner/tenant provided.
3. Provide links to all associated graphics (i.e., AHU to other AHU's and to exhaust systems).
4. Locate pertinent information next to its associated graphic representation.
5. Provide a link to a separate page that displays the system as-built sequence of operation.

E. Monitoring Graphics:

1. Where equipment is monitored for specific information and no 2-way communication is available, it may be grouped on a floor plan or multiple plans.

F. Show the block in its general location with an equipment label and normal and alarm color changing.

G. Custom Graphics: Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics that are saved in industry standard formats such as PCX, TIFF, and GEM. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Designer or AutoCAD.

H. Graphics Library: Furnish a complete library of standard HVAC equipment graphics such as air handlers, fan coils, etc. This library also shall include standard symbols for other equipment including fans, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program.

**3.11 PROGRAMMING**

A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.

B. Point Naming: System point names shall be similar/equivalent to the existing systems.

C. Software Programming:

1. Provide programming for the system and adhere to the sequences of operation provided. All other system programming necessary for the operation of the system, but not specified in this document, also shall be provided by the Contractor. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:

a. Text-based:

- 1) Organized in single purpose blocks of programming.

- 2) Must provide actions for all possible situations.
- 3) Must be modular and structured.
- 4) Must be commented with a description and purpose.

b. Graphic-based:

- 1) Organized in single purpose functional blocks.
- 2) Must provide actions for all possible situations.
- 3) Organize blocks in a neat flowing structure.
- 4) Blocks must be annotated with a description and purpose in a text block.
- 5) Must be documented.

D. Operator Interface:

1. Standard Graphics: Provide graphics for all mechanical systems and floor plans of the building. This includes each hot water system, air handler, and all terminal equipment. Point information on the graphic displays shall dynamically update. Show on each graphic all input and output points for the system. Also show relevant calculated points such as set points.
2. Show terminal equipment information on a "graphic" summary table. Provide dynamic information for each point shown.
3. The Contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all operator interface software and its functions as described in this Section. This includes any operating system software, the operator interface database, and any third party software installation and integration required for successful operation of the operator interface.

### 3.12 ADJUSTING

A. Calibrating and Adjusting:

1. Coordinate onsite time and integration of services with Division 23 Section "Testing, Adjusting, and Balancing of HVAC" to utilize and mutually support activities. Air and water devices requiring flow information for calibration shall be calibrated in conjunction with TAB activities and shall not interfere with the work and general schedule of construction.
2. Calibrate instruments.
3. Make single-point calibration test for accuracy, plus testing of full span for each analog instrument.
4. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
5. Control System Inputs and Outputs:
  - a. Check analog inputs at 0, 50, and 100 percent of span.
  - b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
  - c. Check digital inputs using jumper wire.
  - d. Check digital outputs using ohmmeter to test for contact making or breaking.
  - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
6. Flow:
  - a. Set differential pressure flow transmitters for 0 and 100 percent values with single-point calibration accomplished at approximately mid-point of span, and check full span with an artificial signal generator.
  - b. Manually operate flow switches to verify that they make or break contact.
7. Pressure:
  - a. Calibrate pressure transmitters at approximately mid-point of span, and check full span with an artificial signal generator.
  - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.

8. Temperature:
    - a. Calibrate resistance temperature transmitters at approximately mid-point of span using a precision-resistance source, and check full span with an artificial signal generator.
    - b. Calibrate temperature switches to make or break contacts.
  9. Stroke and adjust control valves and dampers, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
  10. Provide diagnostic and test instruments for calibration and adjustment of system.
  11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

### 3.13 FIELD QUALITY TESTING

- A. Perform the following field tests and inspections and prepare test reports:
1. Category 5e UTP Cabling Tests:
    - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in Annex I, complying with measurement accuracy specified in Annex H. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    - b. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
    - c. Wire-map test that reports open circuits, short circuits, crossed pairs, reversed pairs, split pairs, and improper terminations.
    - d. Channel and permanent link tests for cable length, insertion loss, near-end crosstalk loss, power sum near-end crosstalk loss, equal-level far-end crosstalk loss, power sum equal-level far-end crosstalk, return loss, propagation delay, and delay skew. Performance shall comply with minimum criteria in TIA/EIA-568-B.2.
  2. Category 6 UTP Cabling Tests:
    - a. Tests shall include all tests of Category 5e, conducted from 1 to 250 MHz.
    - b. Channel and permanent link tests shall be performed with a tester that complies with performance requirements in TIA/EIA-568-B.2, Level III. Include tests for longitudinal or transverse conversion loss.
    - c. Performance shall comply with minimum criteria in TIA/EIA-568-B.2.
- B. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. Remove and replace cabling where test results indicate that they do not comply with specified requirements.
- D. Retest and inspect cabling to determine compliance of replaced or additional work with specified requirements.

**3.14 STABILITY TRENDING SET-UP**

- A. Set up trending of points for confirmation of stability and control.
- B. Trend three weeks of data as follows:
  - 1. Trend all analog input values on a 30 minute basis.
  - 2. Trend all digital input points on a change of value basis.
  - 3. Trend all analog virtual points on a 60 minute basis.
- C. Test network capacity according to standards indicated during trending tests.
- D. When trending indicates system instability for certain points, set-up additional trending for one week as follows to facilitate tuning and trouble-shooting:
  - 1. Trend all associated analog input points on a 10 minute basis.
  - 2. Trend all associated digital input points on a change of value basis.
  - 3. Trend all associated analog outputs on a 10 minute basis.
  - 4. Trend all associated digital outputs on a change of value basis.
  - 5. Trend all associated virtual analog points on a 10 minute basis.
  - 6. Trend all associated virtual digital points on a change of value basis.
- E. Reporting system shall automatically email trend reports to the Engineer and the Commissioning Agent on a daily basis.
- F. Continue trending as long as required to enable system stability and trouble shooting. Owner's representative must sign off.
- G. Leave trending of point as directed by Owner's representative for long term information gathering.

**3.15 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Division 01 for additional requirements.
- B. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new outlets. Refer to Division 01 for additional requirements.

**END OF SECTION 23 09 00**  
07/10/2018

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**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. This Section includes control sequences for HVAC systems, subsystems, and equipment.

**1.3 DEFINITIONS**

- A. DDC: Direct-digital controls.
- B. BMS: Building Management System.

**1.4 COMMON REQUIREMENTS**

- A. The following items are common requirements that apply unless noted otherwise:
  - 1. All set points shall be program adjustable at the existing remote operator workstation.
  - 2. All high and low limits shall be alarmed.
  - 3. All hydronic proof of flow shall be via differential pressure sensors.
  - 4. All fan proof of operation shall be by current sensors.
  - 5. All unit smoke detection and emergency shutdown shall be done by hardwired interlock and shall not rely on control system programming.
  - 6. All dampers shall have open and close status indication through end switches or integral actuator feature.
  - 7. All dampers shall have an independent control point. Multiple dampers of different applications (i.e., outdoor, return) controlled from a single point are not acceptable.

**1.5 KITCHEN MAKE-UP AIR UNIT CONTROL**

- A. System Description:
  - 1. Kitchen make-up air unit (MAU-1) is an outdoor constant volume unit with packaged controls with interface to DDC system, gas heating, return air and 100 percent outside air for ventilation.
  - 2. System has occupied and unoccupied modes of operation, adjustable schedule through the BMS.
  - 3. Interlock kitchen exhaust fans with kitchen make-up unit operation. Return air damper shall close and outside air damper shall open to 100% OA when kitchen exhaust fans are indexed on.
- B. Supply-Fan Control: System starts fan to run continuously during occupied periods, and when kitchen exhaust fans are energized. Fan shall cycle during unoccupied periods.
  - 1. Signal alarm if fan fails to start as commanded.
  - 2. Whenever fan is stopped, outdoor air damper shall close.
  - 3. Whenever fan is running during occupied mode and when KEF's are running, outdoor air damper shall be open. Gas furnace shall modulate to maintain space temperature setpoint.
  - 4. During occupied mode, fan shall not be allowed to operate until outdoor air damper proved open.
  - 5. During unoccupied mode, position outside air damper closed and return air damper open. Fan and gas furnace shall cycle to maintain space temperature setpoint.
  - 6. Emergency Shutdown Control: Upon signal from fire alarm panel, stop fan, and close outdoor air damper. All shutdowns shall be hardwired interlocked and shall not rely on control system programming.
  - 7. Smoke Control (Unit Shutdown): Supply and return duct smoke detectors, when products of combustion are detected in airstream, stop fan and close outdoor air damper.



8. Filters: During occupied periods, when fan is running, differential air-pressure transmitter signals alarm when low and high pressure conditions exist across filter bank.
9. Supply Air Temperature Control: When fan is running, system modulates gas heating to maintain space temperature setpoint.
10. During occupied periods, when supply fan is running and kitchen exhaust fans are running, open outside air damper to 100% OA.

C. Operator Station Display-Indicate the following on the remote operator workstation display terminal:

1. System graphic.
2. System on-off indication.
3. System occupied/unoccupied mode.
4. System supply fan on-off alarm indication.
5. Dampers open and closed status indication (all outdoor/return air dampers).
6. Dirty filter indication.
7. Space temperature sensor.
8. Space temperature indication.
9. Space temperature setpoint.
10. Low discharge air temperature alarm.
11. Gas furnace command/status.

**1.6 FAN COIL UNIT CONTROL (FCU-1, FCU-2, FCU-3)**

A. System Description:

1. Fan coil unit is an indoor constant air volume unit with hot water heating and DX cooling with remote condensing unit (CU).
2. System has occupied and unoccupied modes of operation, adjustable schedule through the BMS.

B. Occupied Mode:

1. During the occupied mode of operation, the unit's supply fan shall run to provide conditioned air to the space. The outside air damper shall open to provided scheduled OA.

C. Unoccupied Mode:

1. The unoccupied mode of operation shall commence at the pre-programmed unoccupied start time. During the unoccupied mode, the unit's supply fan shall de-energize and outside air damper shall close.
2. During the unoccupied mode, if the space falls below the night setback temperature, the unit's supply fan shall energize with the outside air damper closed.

D. System Operation:

1. System start/stop is manually selectable through the BMS.
2. When the supply fan starts, the outside air damper shall open to provide scheduled OA. Whenever the fan stops, the outside air damper shall close.
3. If a fan failure occurs at the fan, as detected by current switch on the fan, the failed fan is stopped and a critical alarm is generated at the BMS. This interlock is disabled for 30 seconds (adjustable) after the fan is initially commanded to start. Fan is locked out until manually reset through the BMS.

E. DX Cooling Coil: When fan is running, system cycles condensing unit to maintain space temperature setpoint.

1. When fan is off, condensing unit is off.
2. When fan is on, enable normal control. System modulates condensing unit to maintain space temperature setpoint.
3. When outdoor air is below 55 deg. F condensing unit is off (with the exception of low ambient control, unit has the capability to operate at 0 deg. F. outdoor air).

- F. Hot Water Heating Coil: During occupied periods, when fan is running, system modulates control valve to maintain space temperature setpoint.
  - 1. During unoccupied periods, when fan is off, valve to be in open position.
  - 2. During unoccupied periods, when fan is on, valve to be in open position.
  
- G. Freeze Protection: A low limit temperature sensor on the discharge of the heating coil de-energizes the supply fan when temperature below 40 deg. F (adjustable) is sensed. The outdoor air damper shall fully close. The heating coil valve shall fully open. A critical alarm shall be generated at the BMS.
  - 1. Manual reset to clear alarm and restart unit.
  
- H. High Level Condensate Safety (FCU-3 Only):
  - 1. 24-Volt control including transformer and relay, UL listed to shut down unit fan and generate alarm in the event of high water level in the auxiliary condensate pan.
  
- I. Filters: When fans are running, differential air pressure transmitter signal alarm when low and high pressure conditions exist across filter bank.
  
- J. Coordination of Fan Coil Unit Sequences: Ensure that heating-coil and DX cooling-coil controls have common inputs and do not overlap in function. Provide 2 deg. F. (adjustable) deadband between heating and cooling.
  
- K. Operator Station Display-Indicate the following on the remote operator workstation display terminal:
  - 1. System graphic.
  - 2. System on-off indication.
  - 3. System occupied/unoccupied mode.
  - 4. System supply fan on-off-alarm indication.
  - 5. Dampers open and closed status indication (all outdoor, return air dampers).
  - 6. Heating-coil-air temperature indication.
  - 7. Heating-coil-air temperature setpoint.
  - 8. Heating-coil control-valve position.
  - 9. DX coil air temperature indication.
  - 10. DX coil air-temperature setpoint.
  - 11. Condensing unit command/status.
  - 12. Dirty filter indication.
  - 13. Space temperature sensor.
  - 14. Space temperature indication.
  - 15. Space temperature setpoint.
  - 16. Discharge air temperature.
  - 17. Freezestat.

## **1.7 EXHAUST FANS**

- A. Kitchen Exhaust Fans (KEF-1, KEF-2):
  - 1. System Description: The application consists of kitchen hood exhaust fans. The fans shall be hardwired interlocked with the make-up air unit (MAU-1). The BMS shall control all unit functions. The unit shall be DDC controlled using electric actuation.
  - 2. Occupied Mode:
    - a. Kitchen Exhaust Fans shall be controlled by a local switch with pilot light (by ATC contractor) located in the kitchen, adjacent to kitchen hood. Manually energized, the exhaust fans shall start. The associated make-up air unit (MAU-1) outdoor air damper shall open to provide the required makeup air to the space.
    - b. If kitchen exhaust fans are in operation and the hood suppression system is activated, the exhaust fans shall continue to operate after the extinguishing system has been activated unless fan shutdown is required by a listed component of the ventilation system or by the

design of the extinguishing system. The BMS shall use a current switch to monitor the exhaust fans status.

3. Unoccupied Mode:
    - a. Kitchen Exhaust Fans shall be controlled by a local switch with pilot light (by ATC contractor) in the kitchen, adjacent to kitchen hood. Manually de-energized, the fans shall stop.
  4. Operator Station Display-Indicate the following on the remote operator workstation display terminal:
    - a. Unit identification
    - b. Fan Status
    - c. Fan failure alarm
    - d. Hood suppression system status
- B. Toilet/Locker Room/Janitor Closet exhaust fans (REF-1, REF-2, REF-3) shall be controlled by a time schedule from the BMS. When the fan is commanded to start the respective exhaust damper shall energize open. Once the damper is proven open via end switch, the exhaust fan shall be allowed to start. An amperage switch installed on the exhaust fan motor shall indicate fan status. If the DDC controller is calling for the fan to be on and the amp switch is off, a fan failure alarm shall be sent to the BMS.
1. Operator Station Display-Indicate the following on the remote operator workstation display terminal:
    - a. Unit identification
    - b. Fan status
    - c. Damper end switch status
    - d. Fan failure alarm

## **1.8 TERMINAL UNIT OPERATING SEQUENCE**

- A. Unit Heater, Hydronic: Unit-mounted thermostat cycles fan. (Note: Standalone control. Do not tie into BMS.)
1. Unit-mounted thermostat stops fan when return heating-water space temperature falls below setpoint, subject to aquastat, verifying hot water flow.
- B. Baseboard Radiation, Hydronic:
1. System Description: The application consists of hot water baseboard radiation. The BMS shall control all unit functions. The unit shall be DDC controlled using electric actuation.
  2. Occupied:
    - a. The controller shall monitor the space temperature sensor and cycle the heating valve to maintain the space temperature setpoint.
  3. Unoccupied:
    - a. The baseboard radiation shall be controlled using the unoccupied space temperature setpoint. The heating valve shall be closed when the space temperature setpoint is satisfied.
  4. Operator Station Display-Indicate the following on the remote operator workstation display terminal:
    - a. Unit identification.
    - b. System occupied/unoccupied mode.
    - c. Space temperature sensor.
    - d. Space temperature setpoint.

e. Control valve position - on/off.

C. Convector, Hydronic:

1. System Description: The application consists of hot water convector. The BMS shall control all unit functions. The unit shall be DDC controlled using electric actuation.
2. Occupied:
  - a. The controller shall monitor the space temperature sensor and cycle the heating valve to maintain the space temperature setpoint.
3. Unoccupied:
  - a. The convector shall be controlled using the unoccupied space temperature setpoint. The heating valve shall be closed when the space temperature setpoint is satisfied.
4. Operator Station Display-Indicate the following on the remote operator workstation display terminal:
  - a. Unit identification.
  - b. System occupied/unoccupied mode.
  - c. Space temperature sensor.
  - d. Space temperature setpoint.
  - e. Control valve position - on/off.

**1.9 SPLIT SYSTEM AC UNIT (ACU-1 and CU-1)**

A. System Description:

1. The unit consists of DX cooling coil, supply fan, and remote air cooled condensing unit. BMS shall monitor only and display alarm.

B. The factory furnished controller shall cycle condensing unit to maintain space temperature setpoint.

C. Operator Station Display-Indicate the following on the remote operator workstation display terminal:

1. Unit identification
2. Space temperature sensor
3. Space high temperature alarm

**PART 2 - PRODUCTS (Not Applicable)**

**PART 3 - EXECUTION (Not Applicable)**

**END OF SECTION 23 09 93.11**  
07/10/2018

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**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. Pipes, tubes, and fittings.
  - 2. Piping specialties.
  - 3. Piping and tubing joining materials.
  - 4. Valves.
  - 5. Pressure regulators.

**1.3 DEFINITIONS**

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Minimum Operating-Pressure Ratings:
  - 1. Piping and Valves: 100 psig minimum unless otherwise indicated.
- B. Natural-Gas System Pressures within Buildings: Two pressure ranges. Primary pressure is more than 0.5 psig but not more than 2 psig, and is reduced to secondary pressure of 0.5 psig or less.

**1.5 SUBMITTALS**

- A. Product Data: For each type of the following:
  - 1. Piping specialties.
  - 2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
  - 3. Pressure regulators. Indicate pressure ratings and capacities.
  - 4. Dielectric fittings.
- B. Shop Drawings: For facility natural-gas piping layout. Include plans and attachments to other work. Show different pressure zones and indicate pressure for each zone.
  - 1. Shop Drawing Scale: 1/4 inch per foot.
- C. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

- D. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.
- E. Qualification Data: For qualified professional engineer.
- F. Welding certificates.
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For motorized gas valves and pressure regulators to include in emergency, operation, and maintenance manuals.

#### **1.6 QUALITY ASSURANCE**

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. 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 DELIVERY, STORAGE, AND HANDLING**

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

#### **1.8 PROJECT CONDITIONS**

- A. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:
  - 1. Notify Owner no fewer than two days in advance of proposed interruption of natural-gas service.
  - 2. Do not proceed with interruption of natural-gas service without Owner's written permission.

#### **1.9 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

### **PART 2 - PRODUCTS**

#### **2.1 PIPES, TUBES, AND FITTINGS**

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
  - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
  - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.
  - 3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
  - 4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
    - a. Material Group: 1.1.

- b. End Connections: Threaded or butt welding to match pipe.
  - c. Lapped Face: Not permitted underground.
  - d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.
  - e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.
5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
- a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- B. Drawn-Temper Copper Tube: Comply with ASTM B 88, Type L.
- 1. Copper Fittings: ASME B16.22, wrought copper, and streamlined pattern.
  - 2. Protective Coating for Underground Tubing: Factory-applied, extruded PE a minimum of 0.022 inch thick.

## **2.2 PIPING SPECIALTIES**

- A. Appliance Flexible Connectors:
- 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
  - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
  - 3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
  - 4. Corrugated stainless-steel tubing with polymer coating.
  - 5. Operating-Pressure Rating: 0.5 psig.
  - 6. End Fittings: Zinc-coated steel.
  - 7. Threaded Ends: Comply with ASME B1.20.1.
  - 8. Maximum Length: 72 inches.
- B. Quick-Disconnect Devices: Comply with ANSI Z21.41.
- 1. Copper-alloy convenience outlet and matching plug connector.
  - 2. Nitrile seals.
  - 3. Hand operated with automatic shutoff when disconnected.
  - 4. For indoor or outdoor applications.
  - 5. Adjustable, retractable restraining cable.
- C. Y-Pattern Strainers:
- 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  - 4. CWP Rating: 125 psig.
- D. Basket Strainers:
- 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
  - 2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
  - 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
  - 4. CWP Rating: 125 psig.
- E. T-Pattern Strainers:
- 1. Body: Ductile or malleable iron with removable access coupling and end cap for strainer maintenance.
  - 2. End Connections: Grooved ends.



3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 57 percent free area.
  4. CWP Rating: 750 psig.
- F. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

### **2.3 JOINING MATERIALS**

- A. Joint Compound and Tape: Suitable for natural gas.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

### **2.4 MANUAL GAS SHUTOFF VALVES**

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.
1. CWP Rating: 125 psig.
  2. Threaded Ends: Comply with ASME B1.20.1.
  3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
  4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
  6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.
1. CWP Rating: 125 psig.
  2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
  3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. One-Piece, Bronze Ball Valve with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BrassCraft Manufacturing Company; a Masco company.
    - b. Conbraco Industries, Inc.; Apollo Div.
    - c. Lyall, R. W. & Company, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Perfection Corporation; a subsidiary of American Meter Company.
  2. Body: Bronze, complying with ASTM B 584.
  3. Ball: Chrome-plated brass.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE; blowout proof.
  6. Packing: Separate packnut with adjustable-stem packing threaded ends.
  7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.

8. CWP Rating: 600 psig.
  9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- E. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BrassCraft Manufacturing Company; a Masco company.
    - b. Conbraco Industries, Inc.; Apollo Div.
    - c. Lyall, R. W. & Company, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Perfection Corporation; a subsidiary of American Meter Company.
  2. Body: Bronze, complying with ASTM B 584.
  3. Ball: Chrome-plated bronze.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE; blowout proof.
  6. Packing: Threaded-body packnut design with adjustable-stem packing.
  7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  8. CWP Rating: 600 psig.
  9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- F. Two-Piece, Regular-Port Bronze Ball Valves with Bronze Trim: MSS SP-110.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BrassCraft Manufacturing Company; a Masco company.
    - b. Conbraco Industries, Inc.; Apollo Div.
    - c. Lyall, R. W. & Company, Inc.
    - d. McDonald, A. Y. Mfg. Co.
    - e. Perfection Corporation; a subsidiary of American Meter Company.
  2. Body: Bronze, complying with ASTM B 584.
  3. Ball: Chrome-plated bronze.
  4. Stem: Bronze; blowout proof.
  5. Seats: Reinforced TFE.
  6. Packing: Threaded-body packnut design with adjustable-stem packing.
  7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
  8. CWP Rating: 600 psig.
  9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
  10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.
- G. Bronze Plug Valves: MSS SP-78.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Lee Brass Company.
    - b. McDonald, A. Y. Mfg. Co.
    - c. Xomox Corporation; a Crane Company.
  2. Body: Bronze, complying with ASTM B 584.
  3. Plug: Bronze.

4. Ends: Threaded, socket, or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig.
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

H. Cast-Iron, Nonlubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. McDonald, A. Y. Mfg. Co.
  - b. Mueller Co.; Gas Products Div.
  - c. Xomox Corporation; a Crane company.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

I. Cast-Iron, Lubricated Plug Valves: MSS SP-78.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Flowserve.
  - b. Homestead Valve; a division of Olson Technologies, Inc.
  - c. McDonald, A. Y. Mfg. Co.
  - d. Milliken Valve Company.
  - e. Mueller Co.; Gas Products Div.
  - f. R&M Energy Systems, A Unit of Robbins & Myers, Inc.
2. Body: Cast iron, complying with ASTM A 126, Class B.
3. Plug: Bronze or nickel-plated cast iron.
4. Seat: Coated with thermoplastic.
5. Stem Seal: Compatible with natural gas.
6. Ends: Threaded or flanged as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
7. Operator: Square head or lug type with tamperproof feature where indicated.
8. Pressure Class: 125 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

J. Valve Boxes:

1. Cast-iron, two-section box.
2. Top section with cover with "GAS" lettering.
3. Bottom section with base to fit over valve and barrel a minimum of 5 inches in diameter.
4. Adjustable cast-iron extensions of length required for depth of bury.
5. Include tee-handle, steel operating wrench with socket end fitting valve nut or flat head, and with stem of length required to operate valve.

## 2.5 MOTORIZED GAS VALVES

- A. Automatic Gas Valves: Comply with ANSI Z21.21.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. ASCO Power Technologies, LP; Division of Emerson.
    - b. Honeywell International Inc.
    - c. Johnson Controls.
  2. Body: Brass or aluminum.
  3. Seats and Disc: Nitrile rubber.
  4. Springs and Valve Trim: Stainless steel.
  5. Normally closed.
  6. Visual position indicator.
  7. Electrical operator for actuation by appliance automatic shutoff device.
- B. Electrically Operated Valves: Comply with UL 429.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. ASCO Power Technologies, LP; Division of Emerson.
    - b. Goyen Valve Corp.; Tyco Environmental Systems.
    - c. Magnatrol Valve Corporation.
    - d. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
  2. Pilot operated.
  3. Body: Brass or aluminum.
  4. Seats and Disc: Nitrile rubber.
  5. Springs and Valve Trim: Stainless steel.
  6. 120-V ac, 60 Hz, Class B, continuous-duty molded coil, and replaceable.
  7. NEMA ICS 6, Type 4, coil enclosure.
  8. Normally closed.
  9. Visual position indicator.

## 2.6 PRESSURE REGULATORS

- A. General Requirements:
1. Single stage and suitable for natural gas.
  2. Steel jacket and corrosion-resistant components.
  3. Elevation compensator.
  4. End Connections: Threaded for regulators NPS 2 and smaller; flanged for regulators NPS 2-1/2 and larger.
- B. Line Pressure Regulators: Comply with ANSI Z21.80.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Actaris.
    - b. American Meter Company.
    - c. Eclipse Combustion, Inc.
    - d. Fisher Control Valves and Regulators; Division of Emerson Process Management.
  2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
  3. Springs: Zinc-plated steel; interchangeable.
  4. Diaphragm Plate: Zinc-plated steel.
  5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.

6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet, and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream, and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 2 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Eaton Corporation; Controls Div.
  - b. Harper Wyman Co.
  - c. Maxitrol Company.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 2 psig.

## **2.7 LABELING AND IDENTIFYING**

- A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 PREPARATION**

- A. Close equipment shutoff valves before turning off natural gas to premises or piping section.
- B. Inspect natural-gas piping according to NFPA 54 to determine that natural-gas utilization devices are turned off in piping section affected.
- C. Comply with NFPA 54 requirements for prevention of accidental ignition.

### **3.3 OUTDOOR PIPING INSTALLATION**

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.

- B. Install underground, natural-gas piping buried at least 36 inches below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
  - 1. If natural-gas piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Steel Piping with Protective Coating:
  - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
  - 2. Replace pipe having damaged PE coating with new pipe.
- D. Copper Tubing with Protective Coating:
  - 1. Apply joint cover kits over tubing to cover, seal, and protect joints.
  - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.

### **3.4 INDOOR PIPING INSTALLATION**

- A. Comply with NFPA 54 for installation and purging of natural-gas piping.
- B. Locate valves for easy access.
- C. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.
- D. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- E. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
  - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- F. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap. The term "outdoors" shall imply to mean "above roof." Vent terminations at roof shall be a minimum of 24 inches above roof to vent opening. If the extension of the relief vent piping to above roof is not physically possible, an outdoor location that is acceptable to the authority having jurisdiction may be used with prior written approval. Relief vent piping terminations shall not occur within or near any exhaust or intake areaways. Relief vent piping from other regulators or venting devices shall not be combined. Size of relief vent piping shall be same as the relief opening. Increase relief vent piping by one pipe size for every 25 ft. of developed length.
- G. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- H. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
  - 1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
  - 2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing

rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.
4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
  - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
5. Prohibited Locations:
  - a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
  - b. Do not install natural-gas piping in solid walls or partitions.
- I. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- J. Connect branch piping from top or side of horizontal piping.
- K. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
- L. Do not use natural-gas piping as grounding electrode.
- M. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- N. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

### **3.5 VALVE INSTALLATION**

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

### **3.6 PIPING JOINT CONSTRUCTION**

- A. Use materials suitable for natural gas.
  1. Brazed Joints: Make with brazing alloy with melting point greater than 1000 deg F. Brazing alloys containing phosphorus are prohibited.
- B. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

### **3.7 HANGER AND SUPPORT INSTALLATION**

- A. Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

- C. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1 and Smaller: Maximum span, 96 inches; minimum rod size, 3/8 inch.
  - 2. NPS 1-1/4: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
  - 4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
  - 5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.
  
- D. Install hangers for horizontal drawn-temper copper tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/8: Maximum span, 48 inches; minimum rod size, 3/8 inch.
  - 2. NPS 1/2 and NPS 5/8: Maximum span, 72 inches; minimum rod size, 3/8 inch.
  - 3. NPS 3/4 and NPS 7/8: Maximum span, 84 inches; minimum rod size, 3/8 inch.
  - 4. NPS 1: Maximum span, 96 inches; minimum rod size, 3/8 inch.

### **3.8 CONNECTIONS**

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Corrugated Stainless Steel Tubing (CSST) gas piping shall be bonded in accordance with manufacturer's installation instructions.
- D. Install piping adjacent to appliances to allow service and maintenance of appliances.
- E. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.
- F. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

### **3.9 LABELING AND IDENTIFYING**

- A. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

### **3.10 PAINTING**

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior natural-gas piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Alkyd System: MPI EXT 5.1D.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    - c. Topcoat: Exterior alkyd enamel (semigloss).
    - d. Color: Gray.



- C. Paint exposed, interior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.
  - 1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Interior latex matching topcoat.
    - c. Topcoat: Interior latex (semigloss).
    - d. Color: Gray.
  - 2. Alkyd System: MPI INT 5.1E.
    - a. Prime Coat: Alkyd anticorrosive metal primer.
    - b. Intermediate Coat: Interior alkyd matching topcoat.
    - c. Topcoat: Interior alkyd (semigloss).
    - d. Color: Gray.
- D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

**3.11 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Tests and Inspections:
  - 1. Test, inspect, and purge natural gas according to NFPA 54 and authorities having jurisdiction.
- C. Natural-gas piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

**3.12 GAS PIPING CONDITIONING**

- A. Due to recent concerns regarding odor absorption and/or odor fade of Mercaptan, the chemical added to natural gas to provide a smell so as to indicate its presence in case of a leak, all new gas piping shall be conditioned or "pickled" by the gas company to prevent odor absorption and/or fading of the odorization agent. The conditioning of the gas piping system shall be coordinated and scheduled with the gas company in advance of any gas piping system being turned on for normal use.
- B. Only after the gas piping conditioning process has been completed and accepted by the gas company can the gas piping system be turned over to the Owner for their use.

**3.13 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain earthquake valves.

**3.14 OUTDOOR PIPING SCHEDULE**

- A. Underground natural-gas piping shall be one of the following:
  - 1. Steel pipe with wrought-steel fittings and welded joints, or mechanical couplings. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground natural-gas piping shall be one of the following:
  - 1. Steel pipe with malleable-iron fittings and threaded joints, for piping 2 inches and smaller.

2. Steel pipe with wrought-steel fittings and welded joints, for piping 2-1/2 inches and larger.

C. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

**3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG**

A. Aboveground, branch piping NPS 2 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints, for piping 2 inches and smaller.
2. Steel pipe with wrought-steel fittings and welded joints, for piping 2-1/2 inches and larger.

C. Underground, below building, piping shall be one of the following:

1. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

F. Relief Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints.

**3.16 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG AND LESS THAN 5 PSIG**

A. Aboveground, branch piping NPS 2 and smaller shall be the following:

1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:

1. Steel pipe with malleable-iron fittings and threaded joints, for piping 2 inches and smaller.
2. Steel pipe with steel welding fittings and welded joints, for piping 2-1/2 inches and larger.

C. Underground, below building, piping shall be one of the following:

1. Steel pipe with wrought-steel fittings and welded joints.

D. Containment Conduit: Steel pipe with wrought-steel fittings and welded joints. Coat underground pipe and fittings with protective coating for steel piping.

E. Containment Conduit Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints. Coat underground pipe and fittings with protective coating for steel piping.

F. Relief Vent Piping: Steel pipe with malleable-iron fittings and threaded or wrought-steel fittings with welded joints.

**3.17 UNDERGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE**

A. Connections to Existing Gas Piping: Use valve and fitting assemblies made for tapping utility's gas mains and listed by an NRTL.

- B. Underground:
  - 1. NPS 2 and Smaller: Bronze plug valves.
  - 2. NPS 2-1/2 and Larger: Cast-iron, lubricated plug valves.

**3.18 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE**

- A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
  - 1. Bronze plug valve.
- B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
  - 1. Cast-iron, nonlubricated plug valve.
- C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
  - 1. Bronze plug valve.
- D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
  - 1. Cast-iron, lubricated plug valve.
- E. Valves in branch piping for single appliance shall be one of the following:
  - 1. Bronze plug valve.

**END OF SECTION 23 11 23**  
07/10/2018

**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. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
  - 1. Hot-water heating piping.
  - 2. Air-vent piping.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of the following:
  - 1. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves.
  - 2. Air control devices.
  - 3. Chemical treatment.
  - 4. Hydronic specialties.
- B. Shop Drawings: Detail, CAD-generated and drawn at 1/4-inch scale, the piping layout, fabrication of piping systems, pipe anchors, hangers, valves, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops.
  - 1. Fabrication, assembly and installation including plans, elevations, sections, components, and attachments to other work.
  - 2. Equipment installation based on equipment being used on project.
  - 3. Piping accessories, including access panels.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer.
- B. Field quality-control test reports.
- C. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.
- D. Chemical Removal Certificates: Written and signed certificates from a licensed hazardous chemical removal company.
  - 1. Written, signed approval from the appropriate agencies, water/sewer authorities, and Owner may be substituted for chemical removal where noted herein.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

**1.7 MAINTENANCE SERVICE**

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
  - 1. Initial water analysis and HVAC water-treatment recommendations.
  - 2. Start-up assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
  - 3. Quarterly customer report charts and log sheets.
  - 4. Quarterly certified laboratory technical analysis.
  - 5. Annual certified laboratory legionella analysis.
  - 6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.
  - 7. Monthly service to test all system levels along with written reports and coupon replacement.
  - 8. Monthly maintenance on all equipment.
  - 9. Handling of all chemicals (Owner will not handle chemicals).

**PART 2 - PRODUCTS**

**2.1 COPPER TUBE AND FITTINGS**

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. Wrought-Copper Fittings: ASME B16.22.
- D. Wrought-Copper Unions: ASME B16.22.

**2.2 STEEL PIPE AND FITTINGS**

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.
- E. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.
- F. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.

## 2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

## 2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Hart Industries International, Inc.
    - d. Jomar International Ltd.
    - e. Matco-Norca, Inc.
    - f. McDonald, A. Y. Mfg. Co.
    - g. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - h. Wilkins; a Zurn company.
  - 2. Description:
    - a. Standard: ASSE 1079.
    - b. Pressure Rating: 150 psig.
    - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- C. Dielectric Flanges:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Capitol Manufacturing Company.
    - b. Central Plastics Company.
    - c. Matco-Norca, Inc.
    - d. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    - e. Wilkins; a Zurn company.
  - 2. Description:
    - a. Standard: ASSE 1079.
    - b. Factory-fabricated, bolted, companion-flange assembly.
    - c. Pressure Rating: 150 psig.
    - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric-Flange Insulating Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Advance Products & Systems, Inc.
  - b. Calpico, Inc.
  - c. Central Plastics Company.
  - d. Pipeline Seal and Insulator, Inc.
2. Description:
  - a. Nonconducting materials for field assembly of companion flanges.
  - b. Pressure Rating: 150 psig.
  - c. Gasket: Neoprene or phenolic.
  - d. Bolt Sleeves: Phenolic or polyethylene.
  - e. Washers: Phenolic with steel backing washers.

E. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Elster Perfection.
  - b. Grinnell Mechanical Products.
  - c. Matco-Norca, Inc.
  - d. Precision Plumbing Products, Inc.
  - e. Victaulic Company.
2. Description:
  - a. Standard: IAPMO PS 66
  - b. Electroplated steel nipple. complying with ASTM F 1545.
  - c. Pressure Rating: 300 psig at 225 deg F.
  - d. End Connections: Male threaded or grooved.
  - e. Lining: Inert and noncorrosive, propylene.

**2.5 VALVES**

- A. Ball Valves: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."
- B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."
- C. Bronze, Calibrated-Orifice, Balancing Valves, NPS 2 and Smaller:
  1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
    - a. Bell & Gossett Domestic Pump; a division of ITT Industries.
    - b. Flow Design Inc.
    - c. Griswold Controls.
    - d. Nexus Valve.
    - e. Taco.
  2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
  3. Ball: Brass or stainless steel.
  4. Plug: Resin.
  5. Seat: PTFE.
  6. End Connections: Threaded or socket.

7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.
11. Factory molded insulation kit.
12. Provide "low flow type" valves and sizes for all terminal units (radiation, fan coil units, unit heaters, etc.) where flow rate is 1.5 gpm or less.

D. Multi-Turn, Globe-Style, Balancing Valves, NPS 2 and Smaller:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Armstrong Pumps, Inc.
  - b. Macon Balancing MMA.
  - c. Tour & Andersson.
  - d. Wheatley HVAC.
2. Body: Y-pattern, brass or copper alloy.
3. Balancing Device: Globe valve.
4. Wheel: High-strength resin.
5. Seals: EPDM.
6. End Connections: Threaded or socket.
7. Pressure Gage Connections: Threaded brass ports with check valves and gasketed caps.
8. Handle Style: Handwheel with lockable stop.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.
11. Factory molded insulation kit.
12. Provide "low flow type" valves and sizes for all terminal units (radiation, fan coil units, unit heaters, etc.) where flow rate is 1.5 gpm or less.

E. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves, NPS 1-1/2 to 4:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Bell & Gossett Domestic Pump; a division of ITT Industries.
  - b. Flow Design Inc.
  - c. Griswold Controls.
  - d. Nexus Valve.
  - e. Taco.
2. Body: Cast-iron or steel body, ball, plug, or butterfly pattern with calibrated orifice or venturi.
3. Ball: Brass or stainless steel.
4. Stem Seals: EPDM O-rings.
5. Disc: Glass and carbon-filled PTFE.
6. Seat: PTFE.
7. End Connections: Flanged or grooved.
8. Pressure Gage Connections: Integral seals for portable differential pressure meter.
9. Handle Style: Lever, with memory stop to retain set position.
10. CWP Rating: Minimum 125 psig.
11. Maximum Operating Temperature: 250 deg F.
12. Factory molded insulation kit.

F. Automatic Flow-Control Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - a. Flow Design Inc.
  - b. Griswold Controls.



- c. Nexus.
  - d. Macon Balancing.
- 
- 2. Body: Brass or ferrous metal.
  - 3. Piston and Spring Assembly: Stainless steel or corrosion resistant, tamper proof, self cleaning, and removable.
  - 4. Combination Assemblies: Include bronze or brass-alloy ball valve.
  - 5. Identification Tag: Marked with zone identification, valve number, and flow rate.
  - 6. Size: Same as pipe in which installed.
  - 7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
  - 8. Minimum CWP Rating: 175 psig.
  - 9. Maximum Operating Temperature: 200 deg F.

## **2.6 AIR CONTROL DEVICES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- 1. Amtrol, Inc.
- 2. Armstrong Pumps, Inc.
- 3. Bell & Gossett Domestic Pump; a division of ITT Industries.
- 4. Taco.

- B. Manual Air Vents:

- 1. Body: Bronze.
- 2. Internal Parts: Nonferrous.
- 3. Operator: Screwdriver or thumbscrew.
- 4. Inlet Connection: NPS 1/2.
- 5. Discharge Connection: NPS 1/8.
- 6. CWP Rating: 150 psig.
- 7. Maximum Operating Temperature: 225 deg F.

## **2.7 HYDRONIC PIPING SPECIALTIES**

- A. Y-Pattern Strainers Less than 2-1/2 Inches:

- 1. Body: ASTM B62 C83600 threaded end or ASTM B584 C84400 solder end, cast bronze with bolted cover and bottom drain connection.
- 2. End Connections: Threaded or soldered ends for NPS 2 and smaller.
- 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

- B. Basket Strainers:

- 1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.
- 2. End Connections: Threaded ends for NPS 2 and smaller.
- 3. Strainer Screen: 40-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.
- 4. CWP Rating: 125 psig.

- C. Stainless-Steel Bellow, Flexible Connectors:

- 1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
- 2. End Connections: Threaded or flanged to match equipment connected.
- 3. Performance: Capable of 3/4-inch misalignment.
- 4. CWP Rating: 150 psig.
- 5. Maximum Operating Temperature: 250 deg F.

- D. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

### **PART 3 - EXECUTION**

#### **3.1 PIPING APPLICATIONS**

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be the following:
1. All Locations Unless Noted Otherwise: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
  2. All Locations Unless Noted Otherwise: Schedule 40 steel pipe; Class 150, malleable-iron flanges and flange fittings; and threaded joints with cast-iron or steel fittings.
- B. Air-Vent Piping:
1. Inlet: Same as service where installed.
  2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

#### **3.2 VALVE APPLICATIONS**

- A. Install shutoff-duty valves at each branch connection to supply mains, and at supply connection to each piece of equipment.
- B. Install calibrated, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

#### **3.3 PIPING INSTALLATIONS**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
- B. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."
- Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- R. Install strainers on inlet side of each control valve and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.
- S. Install unions in pipes 2 inches NPS and smaller, adjacent to each valve, at final connections of each piece of equipment and elsewhere as indicated. Unions are not required at flanged connections.
- T. Install flexible connectors at inlet and discharge connections to vibration producing equipment.
- U. Anchor piping for proper direction of expansion and contraction.
- V. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
- W. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."
- X. Install sleeves for piping penetrations of walls and ceilings. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- Y. Install sleeve seals for piping penetrations of concrete walls. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."
- Z. Install escutcheons for piping penetrations of walls and ceilings. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

### **3.4 HANGERS AND SUPPORTS**

- A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports. Piping supports must account and contraction, vibration, and dead load of piping and its contents.
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.

- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes and in accordance with MSS-SP-69:
  - 1. NPS 3/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 2. NPS 1: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
  
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes and in accordance with MSS-SP-69:
  - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 3/8 inch.
  - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

### **3.5 PIPE JOINT CONSTRUCTION**

- A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- E. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8.
- F. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
  - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
  - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

### **3.6 HYDRONIC SPECIALTIES INSTALLATION**

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

### **3.7 TERMINAL EQUIPMENT CONNECTIONS**

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install ports for pressure gages and thermometers at coil inlet and outlet connections and at locations requiring gages and thermometers according to Division 23 Section "Gages for HVAC Piping."

### 3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints uninsulated and exposed for examination during test.
  2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  3. Chemically clean and Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  4. Prior to system flush, remove automatic flow-control cartridges and secure to valve for re-installation after system flush but before balancing.
  5. Isolate equipment from piping. Install valves, caps or blinds in flanged joints at final equipment connection points to isolate equipment. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve.
  6. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
  3. Subject piping system up to equipment final connection points to hydrostatic test pressure of 1.5 times the system's working pressure, minimum 100 psig but shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping." Expansion joints which cannot sustain the reactions due to test pressure shall be provided with temporary restraint or shall be isolated from testing.
  4. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
  5. Once the system is leak free, run the leak test for six hours.
  6. Prepare written report of testing.
- C. Sample water at one week intervals after startup for a period of five weeks, and prepare test report advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" article for each required characteristic. Sample water at six-week intervals following the testing noted above to show the existing automatic chemical feed systems are maintaining water quality within performance requirements specified in this Section.
- D. At six-week intervals following Substantial Completion, perform separate water analyses on hydronic systems to show the existing automatic chemical feed systems are maintain water quality within performance requirements specified in this Section. Submit written reports of water analysis advising Owner of changes necessary to adhere to Part 1 "Performance Requirements" article.
- E. Comply with ASTM D 3370 and with the following standards:
1. Silica: ASTM D 859.
  2. Acidity and Alkalinity: ASTM D 1067.
  3. Iron: ASTM D 1068.
  4. Water Hardness: ASTM D 1126.
- F. Perform the following before operating the system:
1. Open manual valves fully.
  2. Inspect air vents at high points of system and determine if all are installed and bleed air completely (manual type).
  3. Set temperature controls so all coils are calling for full flow.

4. Inspect and set operating temperatures of hydronic equipment to specified values.
5. Verify lubrication of motors and bearings.

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**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. This Section includes refrigerant piping used for air-conditioning applications.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Line Test Pressure for Refrigerant R-410A:
  - 1. Suction Lines for Air-Conditioning Applications: 300 psig.
  - 2. Hot-Gas and Liquid Lines: 535 psig.

**1.4 SUBMITTALS**

- A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:
  - 1. Filter dryers.
- B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.
  - 1. Shop Drawing Scale: 1/4 inch equals 1 foot.
  - 2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.
  - 3. Submit sizing of all piping and riser velocities at minimum and maximum system capacity.
  - 4. Refrigeration based equipment manufacturer(s) shall review the piping design layout, including sizes, risers, piping lengths, double risers and traps and all appurtenances and recommend modifications as required to ensure all warranties remain valid through the specified length of time. Submit a recommendation letter.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

**1.5 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
- B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."
- C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."



**1.6 PRODUCT STORAGE AND HANDLING**

- A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

**PART 2 - PRODUCTS**

**2.1 COPPER TUBE AND FITTINGS**

- A. Copper Tube: ASTM B 280, Type ACR.
- B. Wrought-Copper Fittings: ASME B16.22.
- C. Wrought-Copper Unions: ASME B16.22.
- D. Brazing Filler Metals: AWS A5.8.

**2.2 VALVES AND SPECIALTIES**

- A. Moisture/Liquid Indicators:
  - 1. Body: Forged brass.
  - 2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
  - 3. Indicator: Color coded to show moisture content in ppm.
  - 4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
  - 5. End Connections: Socket or flare.
  - 6. Working Pressure Rating: 500 psig.
  - 7. Maximum Operating Temperature: 240 deg F.
- B. Permanent Filter Dryers: Comply with ARI 730.
  - 1. Body and Cover: Painted-steel shell.
  - 2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
  - 3. Desiccant Media: Activated alumina.
  - 4. End Connections: Socket.
  - 5. Access Ports: NPS 1/4 connections at entering and leaving sides for pressure differential measurement.
  - 6. Maximum Pressure Loss: 2 psig.
  - 7. Working Pressure Rating: 500 psig.
  - 8. Maximum Operating Temperature: 240 deg F.

**2.3 REFRIGERANTS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Atofina Chemicals, Inc.
  - 2. DuPont Company; Fluorochemicals Div.
  - 3. Honeywell, Inc.; Genetron Refrigerants.
  - 4. INEOS Fluor Americas LLC.
- B. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

**PART 3 - EXECUTION**

**3.1 PIPING APPLICATIONS FOR REFRIGERANT**

- A. Hot Gas, Liquid Lines and Suction Lines NPS 4 and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

**3.2 VALVE AND SPECIALTY APPLICATIONS**

- A. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.
- B. Install filter dryers in liquid line between compressor and thermostatic expansion valve.

**3.3 PIPING INSTALLATION**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings.
- B. Install refrigerant piping according to ASHRAE 15.
- C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping adjacent to machines to allow service and maintenance.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation" for sequence of operation.
- K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.
- L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as specified in Division 08 Section "Access Doors and Frames" if valves or equipment requiring maintenance is concealed behind finished surfaces.
- M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.
- N. Slope refrigerant piping as follows:
  - 1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.
  - 2. Install horizontal suction lines with a uniform slope downward to compressor.
  - 3. Install traps and double risers to entrain oil in vertical runs.
  - 4. Liquid lines may be installed level.
- O. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.
- P. Install pipe sleeves at penetrations in exterior wall assemblies.
- Q. Seal penetrations through fire rated walls according to Division 07 Section "Penetration Firestopping."

- R. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.
- S. Install sleeves through walls or ceilings, sized to permit installation of full-thickness insulation.
- T. Seal pipe penetrations through exterior walls according to Division 07 Section "Joint Sealants" for materials and methods.

**3.4 PIPE JOINT CONSTRUCTION**

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
  - 1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.
  - 2. Use Type BA<sub>g</sub>, cadmium-free silver alloy for joining copper with bronze or steel.

**3.5 HANGERS AND SUPPORTS**

- A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.
  - 2. Roller hangers and spring hangers for individual horizontal runs 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:
  - 1. NPS 1/2: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  - 2. NPS 5/8: Maximum span, 60 inches; minimum rod size, 1/4 inch.
  - 3. NPS 1: Maximum span, 72 inches; minimum rod size, 1/4 inch.

**3.6 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Comply with ASME B31.5, Chapter VI.
  - 2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
  - 3. Test high and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    - a. Fill system with nitrogen to the required test pressure.
    - b. System shall maintain test pressure at the manifold gage throughout duration of test.
    - c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    - d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

**3.7 SYSTEM CHARGING**

- A. Charge system using the following procedures:
  - 1. Install core in filter dryers after leak test but before evacuation.
  - 2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for 12 hours, system is ready for charging.
  - 3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
  - 4. Charge system with a new filter-dryer core in charging line.

**3.8 ADJUSTING**

- A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.
- B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.
- C. Adjust set-point temperature of air-conditioning controllers to the system design temperature.
- D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:
  - 1. Verify that compressor oil level is correct.
  - 2. Open compressor suction and discharge valves.
  - 3. Open refrigerant valves except bypass valves that are used for other purposes.
  - 4. Check open compressor-motor alignment and verify lubrication for motors and bearings.

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**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. Single-wall rectangular ducts and fittings.
2. Single-wall round and flat-oval ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.

- B. Related Sections:

1. Division 07 Section "Joint Sealants" for fire-resistant sealants for use around duct penetrations and fire damper installations in fire-rated partitions and walls.
2. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
3. Division 23 Section "Air Duct Accessories" for dampers, duct-mounting access doors and panels, turning vanes, and flexible ducts.

**1.3 DEFINITIONS**

- A. Outside Air: Air originating from outside of the building, from the primary environment surrounding the building. Outside air includes make-up air, fresh air and other types of air.
- B. Conditioned Space: An area, room, ceiling space/plenum or space within the building structure being heated or cooled (by direct expansion) or both, by equipment or appliance and is not subject to outdoor ambient conditions.
- C. Unconditioned Space: An area, room or space within the building structure not being conditioned and subject to outdoor ambient conditions. Above ceiling spaces in ducted return systems are considered unconditioned.
- D. Concealed Ducts/Pipes: Ducts/pipes not visible within the room they are located, after the project is completed.
- E. Exposed Ducts/Pipes: Ducts/pipes visible within the room they are located, after the project is completed.
- F. Ceiling Space/Plenum: An enclosed portion of the building structure, other than an occupiable space being conditioned, that is designed to allow air movement, and thereby serve as part of an air distribution system.
- G. Plenum: Part of duct system connected to diffusers, registers, grilles, louvers for air movement applications.
- H. Moist Exhaust: Exhaust air that carries a higher than ambient level of moisture/humidity in the stream.
1. Examples (including, but not limited to): Shower areas and locker rooms.
- I. Primary Ductwork: Ductwork between the air moving device and the air inlet/outlet (in CV system).

#### 1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2004.

#### 1.5 SUBMITTALS

- A. Product Data: For each type of the following products:
  - 1. Liners and adhesives.
  - 2. Sealants and gaskets.
- B. Shop Drawings:
  - 1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
  - 2. Factory- and shop-fabricated ducts and fittings.
  - 3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
  - 4. Elevation of top of ducts.
  - 5. Dimensions of main duct runs from building grid lines.
  - 6. Fittings.
  - 7. Reinforcement and spacing.
  - 8. Seam and joint construction.
  - 9. Penetrations through fire-rated and other partitions.
  - 10. Equipment installation based on equipment being used on Project.
  - 11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
  - 12. Hangers and supports, including methods for duct and building attachment.
- C. Delegated-Design Submittal:
  - 1. Sheet metal thicknesses.
  - 2. Joint and seam construction and sealing.
  - 3. Reinforcement details and spacing.
  - 4. Materials, fabrication, assembly, and spacing of hangers and supports.
  - 5. Design Calculations: Calculations for selecting hangers and supports.
- D. Welding certificates.
- E. Field quality-control reports.
- F. Contractor Certification for Compliance that all ductwork has been fabricated and installed in accordance with the SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," including duct thickness, joining methods and reinforcing for the applicable pressure classifications.

#### 1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, and AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

- B. Welding Qualifications: Qualify procedures and personnel according to the following:
  - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
  - 2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-Up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.4.4 - "HVAC System Construction and Insulation."
- E. Duct Cleaning: Qualify procedures and personnel with the National Air Duct Cleaners Association (NADCA) recommendations and industry standards for HVAC system cleaning.

## **PART 2 - PRODUCTS**

### **2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS**

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### **2.2 SINGLE-WALL ROUND AND FLAT-OVAL DUCTS AND FITTINGS**

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Lindab Inc.
    - b. EHG Duct.
    - c. McGill AirFlow LLC.
    - d. SEMCO Incorporated.
    - e. Sheet Metal Connectors, Inc.
    - f. Spiral Manufacturing Co., Inc.
- B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).
- C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in



SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," and SMACNA's "Guyed Steel Stacks – Welded Longseam and Spiral Lockseam."

- D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," and SMACNA's "Guyed Steel Stacks – Welded Longseam and Spiral Lockseam."
- E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

### 2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," and SMACNA's "Guyed Steel Stacks – Welded Longseam and Spiral Lockseam" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet and having a No. 2D finish for concealed ducts.
- E. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
  - 1. Where black and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

### 2.4 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Aeroflex USA Inc.
    - b. Armacell LLC.
    - c. Rubatex International, LLC
  - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
  - 3. Liner Adhesive: As recommended by insulation manufacturer.

- B. Insulation Pins and Washers:
1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
  2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- thick galvanized steel; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."
1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
  2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
  3. Butt transverse joints without gaps, and coat joint with adhesive.
  4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
  5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
  6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
  7. Duct Velocities 1,800 FPM and Lower: Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
  8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
    - a. Fan discharges.
    - b. Intervals of lined duct preceding unlined duct.
    - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
  9. Terminate inner ducts with buildouts attached to dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

## 2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Water-Based Joint and Seam Sealant:
1. Application Method: Brush on.
  2. Solids Content: Minimum 65 percent.
  3. Shore A Hardness: Minimum 20.
  4. Water resistant.
  5. Mold and mildew resistant.
  6. VOC: Maximum 75 g/L (less water).
  7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
  8. Service: Indoor or outdoor.
  9. Substrate: Compatible with galvanized sheet steel, stainless steel, or aluminum sheets.
- C. Flanged Joint Sealant: Comply with ASTM C 920.
1. General: Single-component, acid-curing, silicone, elastomeric.
  2. Type: S.

3. Grade: NS.
4. Class: 25.
5. Use: O.

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

## 2.6 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

E. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

F. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

G. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

## PART 3 - EXECUTION

### 3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round and flat-oval ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
  - 1. Exception: Where code required clearances are greater.
- I. Route ducts to avoid passing through egress areas, and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.
- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."
- M. Outside air plenums to louvers or roof vents shall be sealed watertight and sloped to a single point with a drainage fitting connection.
- N. Provide and locate sheet metal baffle plates in ductwork, units, mixing boxes, plenums, etc., as required to eliminate stratification. Affix baffles permanently in place after stratification problem has been eliminated.
- O. Mount all duct mounted smoke detectors in straight lengths of system airflow maintaining minimum distances from elbows and fittings in accordance with manufacturer's instructions and per "Fire Alarm" specification section. Coordinate the application and installation of duct smoke detector types for system air velocities involved per "Fire Alarm" specification section.
- P. Install exterior ductwork with support channels suitable for outdoor applications and duct material being supported.
  - 1. Grade-mounted supports shall be mounted to concrete tube footings per Division 03 requirements. Provide supports at every transition and at intervals per SMACNA, unless noted otherwise. Maintain minimum clearances between grade and bottom of duct for duct size involved in accordance with SMACNA recommendations, unless noted otherwise.

### **3.2 INSTALLATION OF EXPOSED DUCTWORK**

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

### **3.3 ADDITIONAL INSTALLATION REQUIREMENTS FOR COMMERCIAL KITCHEN HOOD EXHAUST DUCT**

- A. Install commercial kitchen hood exhaust ducts without dips and traps that may hold grease, and sloped a minimum of 2 percent to drain grease back to the hood.

- B. Horizontal Tapered Fittings: Eccentric, flat on bottom.

### 3.4 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
  - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
  - 2. Outdoor, Supply-Air Ducts: Seal Class A.
  - 3. Outdoor, Return-Air Ducts: Seal Class B.
  - 4. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
  - 5. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
  - 6. Conditioned Space, Exhaust Ducts: Seal Class B.
  - 7. Conditioned Space, Return-Air Ducts: Seal Class B.

### 3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
  - 1. Where practical, install concrete inserts before placing concrete.
  - 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
  - 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
  - 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1, "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

### 3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

### 3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

### 3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
  - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
  - 2. Test the following systems:
    - a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test all duct sections.
    - b. Ducts with a Pressure Class Lower Than 3-Inch wg : Test all duct sections.
  - 3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
  - 4. Test for leaks after all system access doors are installed.
    - a. Include access doors/access door duct segments in leakage testing and calculations.
  - 5. Test for leaks before applying external insulation.
  - 6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
  - 7. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
  - 1. Visually inspect duct system to ensure that no visible contaminants are present.
  - 2. Where contaminants are discovered, re-clean and reinspect ducts.
  - 3. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
    - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
  - 4. Verification of Existing Coil Cleaning: Cleaning must restore coil pressure drop to within 5 percent of pressure drop measured when coil was first installed. If original pressure drop is not known, coil will be considered clean only if it is free of foreign matter and chemical residue, based on thorough visual inspection.
  - 5. Verify cleanliness after mechanical cleaning and before application of treatment, including biocidal agents and protective coatings.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

### 3.9 DUCT CLEANING

- A. Clean new duct system(s) before testing, adjusting, and balancing.
  - 1. SMACNA Duct Cleanliness Level for New Ductwork: B. Intermediate Level.
- B. Cleaning of new ductwork may be waived by the Engineer if in the sole judgment of the Engineer, appropriate precautions have been taken during construction to cover open ends of ducts and otherwise keep the ductwork clean.
- C. Use service openings for entry and inspection.
  - 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner

as recommended by duct liner manufacturer. Comply with Division 23 Section "Air Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
3. Remove and reinstall ceiling to gain access during the cleaning process.

D. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

E. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums, scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

F. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

G. Additional Requirements for Cleaning Existing Systems:

1. Use service openings, as required, for physical and mechanical entry and for inspection.
  - a. Use existing service openings where possible.
  - b. Create other openings to comply with duct standards.
  - c. Disconnect flexible ducts as needed for cleaning and inspection.
  - d. Reseal rigid fiberglass duct systems according to NAIMA recommended practices.
  - e. Remove and reinstall ceiling sections to gain access during the cleaning process.
2. Mark position of dampers and air-directional mechanical devices before cleaning, and restore to their marked position on completion.
3. Clean the following metal duct systems by removing surface contaminants and deposits:
  - a. Air outlets and inlets (registers, grilles, and diffusers).
  - b. Supply, return, and exhaust fans including fan housings, plenums, scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

- c. Air handling unit internal surfaces and components including mixing box, coil section, condensate drain pans, filters and filter sections, and condensate collectors and drains.
- d. Coils and related components.
- e. Return air ducts, dampers, and actuators.
- f. Supply air ducts, dampers, actuators, and turning vanes.
- g. Dedicated exhaust and ventilation components and make-up air systems.

**3.10 START UP**

- A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

**3.11 DUCT SCHEDULE**

- A. Duct static pressure classifications shall be a minimum of the higher of either the fan developed static pressure or the scheduled value below.

Category	Connecting	Pressure Class <sup>ab</sup>	Seal Class <sup>a</sup>	Leakage Class <sup>a</sup>		Material <sup>f</sup>
				Rect.	Round	
Supply Air	Terminal <sup>c</sup>	2"	A	LC-16	LC-8	G
	AHU <sup>d</sup>	4"	A	LC-8	LC-4	G
Return Air	Terminal <sup>c</sup>	2"	A	LC-16	LC-8	G
	AHU <sup>d</sup>	4"	A	LC-8	LC-4	G
Exhaust Air	Class 1	2"	A	LC-16	LC-8	G
	Kitchen	4"	Welded	LC-8	LC-4	B/S1 <sup>g</sup>
	Moisture	3"	Welded	LC-8	LC-4	S1
Outside Air	Terminal <sup>c</sup>	1"	A	LC-16	LC-8	G

1. Table Notes:

- a. Duct classifications according to the latest versions of SMACNA.
- b. Pressure class in inches water gauge (" w.g.).
- c. Terminal designation includes ducts connected to fan coil units.
- d. "AHU" indicates all air handling equipment including dedicated outside air units, etc., moving primary air through the building.
- e. Air classifications as defined by ASHRAE 62.1.
  - 1) Ducts connected to fans exhausting Class 1 and 2 air.
- f. Material Designations: G = galvanized sheetmetal, S1 = 304L stainless steel, B = black iron.
- g. Concealed: carbon-steel sheet.

B. Supply Ducts:

1. Ducts Connected to Fan Coil Units:

- a. Pressure Class: Positive 2-inch wg.
- b. Minimum SMACNA Seal Class: B.
- c. SMACNA Leakage Class for Rectangular: 12.
- d. SMACNA Leakage Class for Round and Flat Oval: 12.

2. Ducts Connected to Air-Handling Units:

- a. Pressure Class: Positive 4-inch wg.
- b. Minimum SMACNA Seal Class: A.
- c. SMACNA Leakage Class for Rectangular: 3.
- d. SMACNA Leakage Class for Round and Flat Oval: 3.



C. Return Ducts:

1. Ducts Connected to Fan Coil Units:
  - a. Pressure Class: Positive or negative 1-inch wg.
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 12.
2. Ducts Connected to Air-Handling Units:
  - a. Pressure Class: Positive or negative 3-inch wg.
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 6.

D. Exhaust Ducts:

1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
  - a. Pressure Class: Negative 2-inch wg.
  - b. Minimum SMACNA Seal Class: B if negative pressure, and A if positive pressure.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 12.
2. Ducts Connected to Commercial Kitchen Hoods:
  - a. Concealed: Carbon-steel sheet.
  - b. Welded seams and joints.
  - c. Pressure Class: Positive 4-inch wg.
  - d. Minimum SMACNA Seal Class: Welded seams, joints, and penetrations.
  - e. SMACNA Leakage Class: 3.
3. Ducts Connected to Moisture Exhaust Sources:
  - a. Stainless steel.
  - b. Concealed: 304L.
  - c. Welded seams and joints.
  - d. Pressure Class: Positive or negative 3-inch wg.
  - e. Minimum SMACNA Seal Class: Welded seams and joints.
  - f. SMACNA Leakage Class: 3.

E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:

1. Ducts Connected to Fan Coil Units:
  - a. Pressure Class: Positive or negative 1-inch wg.
  - b. Minimum SMACNA Seal Class: B.
  - c. SMACNA Leakage Class for Rectangular: 12.
  - d. SMACNA Leakage Class for Round and Flat Oval: 12.

F. Intermediate Reinforcement:

1. Galvanized-Steel Ducts: Galvanized steel.
2. Stainless-Steel Ducts: Match duct material.

G. Liner:

1. Liner Schedule (Minimum Thickness):

	<b>Conditioned Spaces</b>	<b>Unconditioned Spaces</b>	<b>Outside of Building</b>
Supply	1"	2"	2"
Return	1"	2"	2"

2. Plenums: Flexible elastomeric, 2 inches thick.
3. Additional thickness of duct liner may be substituted for external insulation to match external insulation R-value specification.
4. Increase sheet metal dimensions to maintain specified clear opening duct dimensions.
5. Applications:
  - a. In Proximity of Supply Fans: 15 ft. downstream in direction of outlets.
  - b. Fan Coil Units: 10 ft. up or downstream in direction of outlets.
  - c. Other Locations: As indicated.

H. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Velocity 1000 fpm or Lower and Secondary Ductwork:
    - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
    - 2) Mitered Type RE 4 without vanes.
  - b. Velocity 1000 to 1500 fpm:
    - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - c. Velocity 1500 fpm or Higher:
    - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
  - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
  - b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
  - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
  - d. Kitchen Exhaust: Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."

- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
    - 1) Velocity 1000 fpm or Lower and Secondary Ductwork: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
    - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
    - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
    - 4) Radius-to Diameter Ratio: 1.5.
    - 5) Kitchen Exhaust Radius-to-Diameter Ratio: 1.5.
  - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
  - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam.
- I. Branch Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible, Chapter: "Fittings and Other Construction."
    - a. Rectangular Main to Rectangular Branch: Bell-mouth or 45-degree entry.
    - b. Rectangular Main to Round Branch: Bell-mouth.
    - c. Divided Supply Flow Branches Above 1,000 FPM and Primary Ductwork: Types 1, 2W, 4A and 4B are acceptable.
    - d. Divided Supply Flow Branches 1,000 FPM and Below and Secondary Ductwork: Types 1, 2W, 3, 4A and 4B are acceptable.
    - e. Divided Return Flow Branches Above 1,000 FPM: Types 1, 2W, 4A and 4B are acceptable.
  - 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
    - a. Velocity 1000 fpm or Lower and Secondary Ductwork: Conical tap.
    - b. Velocity 1000 to 1500 fpm: Conical tap.
    - c. Velocity 1500 fpm or Higher: 45-degree lateral.

**END OF SECTION 23 31 13**  
07/10/2018

**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. Manual volume dampers.
2. Fire Dampers.
3. Turning vanes.
4. Duct-mounted access doors.
5. Flexible connectors.
6. Flexible ducts.
7. Duct accessory hardware.

- B. Related Sections:

1. Division 08 Section "Access Doors and Frames" for wall- and ceiling-mounted access doors and panels.
2. Division 08 Section "Louvers and Vents" for intake and relief louvers and vents connected to ducts and installed in exterior walls.
3. Division 23 Section "Instrumentation and Controls for HVAC" for electric damper actuators and control dampers.
4. Division 23 Section "Diffusers, Registers, and Grilles".
5. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

**1.3 SUBMITTALS**

- A. Product Data: For each type of product indicated.

- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:

- a. Special fittings.
- b. Manual volume damper installations.
- c. Fire damper installations. Include manufacturer's NRTL rating installation instructions in submittal.

- C. Source quality-control reports.

- D. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

**1.4 QUALITY ASSURANCE**

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with AMCA 500-D testing for damper rating.

**PART 2 - PRODUCTS**

**2.1 MATERIALS**

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.
- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
  - 1. Galvanized Coating Designation: G60.
  - 2. Exposed-Surface Finish: Mill phosphatized.
- C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts.
- D. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for stainless-steel ducts.
- E. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

**2.2 FIRE DAMPERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Air Balance Inc.; a division of Mestek, Inc.
  - 2. Greenheck Fan Corporation.
  - 3. McGill AirFlow LLC.
  - 4. Prefco; Perfect Air Control, Inc.
  - 5. Ruskin Company.
- B. Type: Dynamic rated and labeled according to UL 555 by an NRTL. Static rated dampers will be unacceptable.
- C. Closing rating in ducts up to 4-inch wg. static pressure class and minimum 2000 fpm velocity.
- D. Fire Rating: 1-1/2 or 3 hours as required by code for rating of the construction penetrated.
- E. Frame: Curtain type with bladed outside airstream for 2000 fpm rated dampers; fabricated with roll formed, 0.034-inch thick galvanized steel; with mitered and interlocking corners.
  - 1. Provide stainless steel type for applications per Part 3.

- F. Mounting Sleeve: Factory supplied, galvanized sheet steel. Field fabricated sleeves will be unacceptable unless special conditions warrant, upon which request must be submitted to the engineer for review and acceptance prior to installation.
  - 1. Provide stainless steel type for applications per Part 3.
  - 2. Minimum Thickness: As required by manufacture's installation instructions for NRTL rating, and of length to suit application.
  - 3. Exception: Omit damper sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch thick, galvanized sheet steel. In place of interlocking blades, use full length, 0.034-inch thick, galvanized steel blade connectors.
  - 1. Provide stainless steel type construction for application per Part 3.
- I. Heat Responsive Device: Replaceable 165 deg. F. rated, fusible links.

### **2.3 MANUAL VOLUME DAMPERS**

- A. Standard, Steel, Manual Volume Dampers:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Air Balance Inc.; a division of Mestek, Inc.
    - b. American Warming and Ventilating; a division of Mestek, Inc.
    - c. McGill AirFlow LLC.
    - d. METALAIRE, Inc.
    - e. Nailor Industries Inc.
    - f. Ruskin Company.
  - 2. Standard leakage rating, with linkage outside airstream.
  - 3. Suitable for horizontal or vertical applications.
  - 4. Frames:
    - a. Hat-shaped, galvanized or stainless-steel channels, 0.064-inch minimum thickness suitable for application.
    - b. Mitered and welded corners.
    - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
  - 5. Blades:
    - a. Multiple or single blade. Use multiple blade dampers in ducts greater than 2 sq. ft. in cross-section.
    - b. Opposed-blade design.
    - c. Stiffen damper blades for stability.
    - d. Galvanized or stainless-steel, 0.064 inch thick suitable for application.
  - 6. Blade Axles: Galvanized steel or stainless steel suitable for application.

- 7. Bearings:
  - a. Oil-impregnated bronze or molded synthetic or stainless-steel sleeve suitable for application.
  - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
- 8. Tie Bars and Brackets: Galvanized steel.

#### **2.4 TURNING VANES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. METALAIRE, Inc.
  - 4. SEMCO Incorporated.
  - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."
- D. Vane Construction: Double wall.

#### **2.5 DUCT-MOUNTED ACCESS DOORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.; Model "Sandwich."
  - 2. McGill AirFlow LLC; Model "Standard Bolted Access Door."
  - 3. Pottorff; a division of PCI Industries, Inc.; Model "DMHC."
  - 4. Ruskin; Model "ADF."
  - 5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.; Model "DSA."
- B. Panels:
  - 1. Insulated Ducts: Access door consists of three layers of precision stamped steel. The inside panel consists of two layers of metal which are spot welded together along the rim encapsulating high density fiberglass or closed cell foam insulation UL classified FHC25/50.
  - 2. Uninsulated Ducts: Access door consists of two layers of precision stamped steel.
- C. Gasket: Closed cell neoprene gasket is UL94HF1 listed with a service temperature range of (ASTM D746) -20 deg. F to 200 deg. F. The gasket is bonded to the inside panel of the access door to insure consistent installations.
- D. Springs: Zinc-plated conical springs are installed, between the inner and outer door, to facilitate opening.
- E. Knobs: Polypropylene molded knobs have threaded metal inserts to eliminate thread stripping. Knobs are easily turned by hand. Knobs are UL94HB listed.

- F. Bolts: Zinc-plated carriage bolts are secured to inner door.
- G. Leakage Rating: Less than 1 cfm at 8" wg.

## **2.6 FLEXIBLE CONNECTORS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Ductmate Industries, Inc.
  - 2. Duro Dyne Inc.
  - 3. Hardcast.
  - 4. Ventfabrics, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 3-1/2 inches or 5-3/4 inches wide attached to 2 strips of 2-3/4-inch- wide, 0.028-inch- thick, galvanized sheet steel. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
  - 1. Minimum Weight: 26 oz./sq. yd.
  - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
  - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, hypalon synthetic rubber resistant to UV rays and ozone.
  - 1. Minimum Weight: 24 oz./sq. yd..
  - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
  - 3. Service Temperature: Minus 50 to plus 250 deg F.

## **2.7 FLEXIBLE DUCTS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Buckley Associates, Inc.
  - 2. Flexmaster U.S.A., Inc.
  - 3. Novaflex Inc.
  - 4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.
- B. Insulated, Flexible Duct: UL 181, Class 1, multiple layers of aluminum laminate, aluminum laminate and polyester film with latex adhesive, vinyl-coated fiberglass cloth, or similar material, supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene or aluminized vapor-barrier film.
  - 1. Pressure Rating: 10-inch wg positive and 5.0-inch wg negative.
  - 2. Maximum Air Velocity: 4000 fpm.
  - 3. Temperature Range: Minus 20 to plus 210 deg F.
  - 4. Insulating Value: R6.0.



- C. Flexible Duct Connectors:
  - 1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

- D. Flexible Duct Accessories:
  - 1. Elbow Forms: 100 percent recycled copolymer polypropylene "I" shaped form attached with nylon bands.

## **2.8 DUCT ACCESSORY HARDWARE**

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and stainless-steel accessories in stainless-steel ducts.
- C. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts and as follows. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
  - 1. Coordinate subparagraphs below with Division 23 Section "Metal Ducts. "Install steel volume dampers in steel ducts.
  - 2. Install stainless steel volume dampers in stainless steel ducts.
  - 3. Constant volume supply, return, exhaust, and outdoor air branch duct takeoffs.
  - 4. Constant volume supply, return, exhaust, and outdoor air mains upstream/downstream of branch duct takeoffs.
  - 5. Large primary variable volume supply air branch duct takeoffs from mains and at shafts.
  - 6. Takeoffs to diffusers, registers, and grilles.
  - 7. Additional locations as required for air balancing to achieve specified airflows.
  - 8. Exceptions: Volume dampers are not required to be installed in grease exhaust ducts.
- D. Set dampers to fully open position before testing, adjusting, and balancing.
- E. Install test holes at fan inlets and outlets and elsewhere as required for testing and balancing.
- F. Install fire dampers in all fire-rated walls and partitions as required by code. Install fire dampers according to UL listing.
  - 1. Install galvanized steel dampers in galvanized steel duct systems.
  - 2. Install stainless steel dampers in stainless steel duct systems.

- G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
  - 1. Downstream from control dampers and equipment.
  - 2. Adjacent to and close enough to fire dampers, to reset or reinstall fusible links.
  - 3. At each change in direction and at maximum 50-foot spacing.
  - 4. Adjacent to internally-mounted smoke detectors.
  - 5. To interior of grease ducts in accordance with applicable codes.
  - 6. Elsewhere as indicated.
  
- H. Install access doors with swing against duct static pressure.
  
- I. Access Door Sizes: Size access doors suitably to perform required or recommended inspection, adjusting, or maintenance and service as appropriate for the component being accessed, as follows:
  - 1. One-Hand or Inspection Access: 8 by 5 inches.
  - 2. Two-Hand Access: 12 by 6 inches.
  - 3. Head and Hand Access: 18 by 10 inches.
  
- J. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
  
- K. Install flexible connectors to connect ducts to equipment. Type of connector shall be suitable for application involved and as follows:
  - 1. Use 3-1/2 inch metal edge connectors on systems below 10,000 cfm.
  - 2. Use indoor type connectors for all systems located indoors.
  - 3. Use outdoor type connectors for all system located outdoors.
  - 4. Do not use flexible connectors on grease exhaust systems.
  
- L. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.
  
- M. Connect flexible ducts to metal ducts with draw bands.
  
- N. Install duct test holes where required for testing and balancing purposes.
  
- O. Install elbow forms at every flexible duct bend.
  
- P. Flexible Duct Applications:
  - 1. Supply Diffusers: Insulated flexible duct, 5-ft. to 6-ft. length with a minimum of one 90-degree bend in addition to the diffuser connection.

### **3.2 FIELD QUALITY CONTROL**

- A. Tests and Inspections:
  - 1. Operate dampers to verify full range of movement.
  - 2. Operate fire dampers to verify full range of movement and verify that proper heat-response device is installed.

3. Inspect locations of access doors and verify that purpose of access door can be performed.
4. Inspect turning vanes for proper and secure installation.

**END OF SECTION 23 33 00**  
07/10/2018

**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. This Section includes the following:
  - 1. Centrifugal roof ventilators.
  - 2. Centrifugal wall ventilators.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Project Altitude: Base fan-performance ratings on sea level.

**1.4 SUBMITTALS**

- A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
  - 1. Certified fan performance curves with system operating conditions indicated. Provide family of curves at different operating speeds with "do not select left of" line indicated. Curves showing only a single speed and the system operating point will not be acceptable.
  - 2. Certified fan sound-power ratings.
  - 3. Motor ratings and electrical characteristics, plus motor and electrical accessories.
  - 4. Material thickness and finishes.
  - 5. Roof curbs and curb adapters.
  - 6. Fan speed controllers.
  - 7. Manufacturer's installation requirements including clearances and recommended inlet and outlet configuration.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

**1.5 QUALITY ASSURANCE**

- A. 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 intended use.
- B. AMCA 211 and 311 Compliance: Products shall comply with air and sound performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
- C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.
- D. UL Standard: Power ventilators shall comply with UL 705.

- E. UL Standard: Provide power ventilators that comply with UL 762 and are UL listed for grease removal on all commercial grease exhaust systems.

**1.6 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.
- B. Lift and support units with manufacturer's designated lifting or supporting points.

**1.7 COORDINATION**

- A. Coordinate installation of roof curbs, curb adapters and roof penetrations with roofing.

**1.8 EXTRA MATERIALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Belts: One set for each belt-driven unit.

**PART 2 - PRODUCTS**

**2.1 CENTRIFUGAL ROOF VENTILATORS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Acme Engineering & Mfg. Corp.
  - 2. Twin City Fan Company
  - 3. Greenheck.
  - 4. Loren Cook Company.
- B. Description: Direct-driven centrifugal fans as indicated in Schedule consisting of housing, wheel, motor and disconnect switch, curb base, lifting lugs, and accessories.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with welded corners and venturi inlet cone.
- D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.
- E. Accessories:
  - 1. Enclosed Switch: Non-fusible type, mounted inside motor compartment, factory wired through an internal aluminum conduit.
  - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  - 3. Potentiometer dial pre-mounted on electronically commutated motor for speed control.
- F. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- thick, 3 lb. density, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch pressure treated wood nailer. Size as required to suit roof opening and fan base.
  - 1. Configuration: Built-in raised cant and mounting flange for insulated roofs.
  - 2. Overall Height: 12 inches minimum for general exhaust.
  - 3. Provide curb adapters for new exhaust fans when located on existing roof curbs. (as noted on schedules).

## **2.2 CENTRIFUGAL WALL VENTILATORS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
  - 1. Acme Engineering & Mfg. Corp.
  - 2. Twin City Fan Company.
  - 3. Greenheck.
  - 4. Loren Cook Company.
- B. Description: Belt-driven centrifugal fans as indicated in Schedule, consisting of housing, wheel, fan shaft, bearings, motor and fused disconnect switch, drive assembly, lifting lugs, and accessories. UL-762 listed fan for grease exhaust systems.
- C. Housing: Removable, spun-aluminum, dome top and outlet baffle; venturi inlet cone.
- D. Fan Wheel: Aluminum hub and wheel with backward-inclined blades.
- E. Belt-Driven Drive Assembly: Resiliently mounted to housing, with the following features:
  - 1. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.
  - 2. Shaft Bearings: Regreasable, permanently sealed, self-aligning ball bearings in cast-iron housing.
  - 3. Pulleys: Cast-iron, adjustable-pitch motor pulley.
  - 4. Fan and motor isolated from exhaust airstream.
- F. Accessories:
  - 1. Enclosed Switch: Fusible type, mounted outside fan housing within NEMA 3R enclosure insulating heat baffle, for grease exhaust fans.
  - 2. Bird Screens: Removable, 1/2-inch mesh, aluminum or brass wire.
  - 3. Belt tensioner on fans with wheel diameter of 10 to 21 inches.

## **2.3 MOTORS**

- A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
- B. Enclosure Type: Open drip-proof for general applications.

## **2.4 SOURCE QUALITY CONTROL**

- A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.
- B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install power ventilators level and plumb.
- B. Secure roof-mounting fans to roof curbs or curb adapters with cadmium-plated hardware.
- C. Install units with clearances for service and maintenance.

- D. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

**3.2 CONNECTIONS**

- A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."
- B. Install ducts adjacent to power ventilators to allow service and maintenance.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

**3.3 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Verify that shipping, blocking, and bracing are removed.
  - 2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
  - 3. Verify that cleaning and adjusting are complete.
  - 4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system, align and adjust belts, and install belt guards.
  - 5. Adjust belt tension.
  - 6. Adjust damper linkages for proper damper operation.
  - 7. Verify lubrication for bearings and other moving parts.
  - 8. Verify that manual dampers in connected ductwork systems are in fully open position.
  - 9. Disable automatic temperature-control operators, energize motor and adjust fan to indicated rpm, and measure and record motor voltage and amperage.
  - 10. Shut unit down and reconnect automatic temperature-control operators.
  - 11. Remove and replace malfunctioning units and retest as specified above.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

**3.4 ADJUSTING**

- A. Adjust damper linkages for proper damper operation.
- B. Adjust belt tension.
- C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
- D. Replace fan and motor pulleys as required to achieve design airflow.
- E. Lubricate bearings.

**END OF SECTION 23 34 23**  
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**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. Ceiling- and wall-mounted diffusers, registers, and grilles.
- B. Related Sections:
  - 1. Section 233300 "Air Duct Accessories" for volume-control dampers not integral to diffusers, registers, and grilles.
  - 2. Section 230713 "Duct Insulation" for insulating of components related to diffusers, registers, and grilles.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated, include the following:
  - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
  - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: Manufacturer color charts showing full range of colors available for diffusers, registers, and grilles with factory-applied color finishes.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Source quality-control reports.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide diffusers, registers, and grilles by one of the following:
  - 1. Diffusers, registers, and grilles, except as indicated otherwise:
    - a. Krueger.
    - b. Nailor.
    - c. Price Industries.
    - d. Titus.
    - e. Tuttle & Bailey.

**2.2 MANUFACTURED UNITS**

- A. Diffuser, register, and grille accessories and requirements are scheduled on the drawings.



**2.3 COLOR AND MATERIAL**

- A. Color and finish of outlets and inlets shall be as selected by the Architect from the manufacturer's standard finishes, unless otherwise indicated.

**2.4 SOURCE QUALITY CONTROL**

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

**PART 3 - EXECUTION**

**3.1 APPLICATION**

- A. Provide materials listed in Schedules, except where indicated and as follows:
  - 1. Provide units of all aluminum construction in high humidity environments, including but not limited to: showers, locker rooms, etc.
  - 2. Provide units with OBD's (opposed blade dampers) where the installation of a volume damper in the branch duct serving the RGD is not possible.

**3.2 EXAMINATION**

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.3 INSTALLATION**

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location. Coordinate with the architectural reflected ceiling plans for exact locations. Provide mounting flanges and frames compatible with the ceiling construction types in all areas.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers.
- D. Support ceiling-mounted outlets and inlets from ductwork and associated hangers to building structure. Ceiling-mounted outlets and inlets may be supported from the suspended ceiling system only where the ceiling system is seismically rated.
- E. Maximum run of flexible duct to diffusers, per Division 23 Section "Duct Accessories."
- F. Install diffusers, registers, and grilles without screws or fasteners visible from finished side. Provide mounting clips, frames, brackets, or other materials necessary to firmly mount inlets and outlets in walls or ceilings.

**3.4 ADJUSTING**

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

**3.5 CLEANING**

- A. After installation of diffusers, registers, and grilles, inspect exposed finish. Clean exposed surfaces to remove burrs, dirt, and smudges. Replace diffusers, registers, and grilles that have damaged finishes.

**END OF SECTION 23 37 13**  
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**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 packaged, refrigerant compressor and condenser units.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each compressor and condenser unit. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include equipment dimensions, weights and structural loads, required clearances, method of field assembly, components, and location and size of each field connection.
- B. Shop Drawings: For compressor and condenser units. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For compressor and condenser units to include in emergency, operation, and maintenance manuals.

**1.6 QUALITY ASSURANCE**

- 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 application.
- B. Fabricate and label refrigeration system according to ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6, "Heating, Ventilating, and Air-Conditioning."
- D. ANSI/ASHRAE/IESNA Standard 90.1 Compliance: Equipment shall meet or exceed the minimum efficiency requirements of the standard. Equipment shall bear a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

**1.7 COORDINATION**

- A. Coordinate sizes and locations of concrete bases for grade mounted units. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033100 "Site Cast-In-Place Concrete."
- B. Coordinate sizes and location of equipment support rails for roof mounted units.

- C. Coordinate location of piping and electrical rough-ins.

**1.8 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of compressor and condenser units that fail in materials or workmanship within specified warranty period.
  - 1. Failures include, but are not limited to, the following:
    - a. Compressor failure.
    - b. Condenser coil leak.
  - 2. Warranty Period (Compressor): Five years from date of Substantial Completion.
  - 3. Warranty Period (Condenser Coil): Five years from date of Substantial Completion.
  - 4. Warranty Period (Components other than Compressor and Condenser Coil): One year from date of Substantial Completion.

**PART 2 - PRODUCTS**

**2.1 COMPRESSOR AND CONDENSER UNITS, AIR COOLED, 1 TO 5 TONS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. AAON, Inc.
  - 2. Carrier Corporation; a unit of United Technologies Corp.
  - 3. Trane.
  - 4. YORK; a Johnson Controls company.
- B. Description: Factory assembled and tested; consisting of compressor, condenser coil, fan, motors, refrigerant reservoir, and operating controls.
- C. Compressor: Scroll, hermetically sealed, with rubber vibration isolators.
  - 1. Motor: Single speed, and includes thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - 2. Two-Speed Compressor: Include manual-reset, high-pressure switch and automatic-reset, low-pressure switch. Provide digital uploading as an alternate.
  - 3. Accumulator: Suction tube.
- D. Refrigerant: R-410A.
- E. Condenser Coil: Seamless copper-tube, aluminum-fin coil; circuited for integral liquid subcooler, with removable drain pan and brass service valves with service ports.
- F. Condenser Fan: Direct-drive, aluminum propeller fan; with permanently lubricated, totally enclosed fan motor with thermal-overload protection.
- G. Accessories:
  - 1. Filter-dryer.
  - 2. High-Pressure Switch: Automatic-reset switch cycles compressor off on high refrigerant pressure.
  - 3. Low-Ambient Controller: Cycles condenser fan to permit operation down to 0 deg F.
  - 4. Low-Pressure Switch: Automatic-reset switch cycles compressor off on low refrigerant pressure.
  - 5. Thermostatic expansion valve.
  - 6. Evaporator defrost control.
  - 7. Cycle Protector: Automatic-reset timer to prevent rapid compressor cycling.

8. Hard start kit.

H. Unit Casing: Galvanized steel, finished with baked enamel; with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Mount service valves, fittings, and gage ports on exterior of casing.

## **2.2 MOTORS**

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

## **2.3 SOURCE QUALITY CONTROL**

A. Verification of Performance: Rate compressor and condenser units according to ARI 210/240.

B. Energy Efficiency: Equal to or greater than prescribed by ASHRAE/IESNA 90.1, "Energy Efficient Design of New Buildings except Low-Rise Residential Buildings," Section 6, "Heating, Ventilating, and Air-Conditioning."

C. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

D. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of compressor and condenser units.

B. Examine roughing-in for refrigerant piping systems to verify actual locations of piping connections before equipment installation.

C. Examine concrete pads and equipment support rails for suitable conditions where compressor and condenser units will be installed.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 INSTALLATION**

A. Install units level and plumb, firmly anchored in locations indicated.

B. Equipment Mounting:

1. Install grade mounted compressor and condenser units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033100 "Site Cast-in-Place Concrete."

2. Install roof mounted compressor and condenser units on (2) 24 inch high equipment support rails.

3. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Systems."

C. Maintain manufacturer's recommended clearances for service and maintenance.

- D. Loose Components: Install electrical components, devices, and accessories that are not factory mounted.

### **3.3 CONNECTIONS**

- A. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- B. Connect refrigerant piping to air-cooled compressor and condenser units; maintain required access to unit. Install furnished field-mounted accessories. Refrigerant piping and specialties are specified in Section 232300 "Refrigerant Piping."

### **3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test. Certify compliance with test parameters.
  - 2. Leak Test: After installation, charge system with refrigerant and oil and test for leaks. Repair leaks, replace lost refrigerant and oil, and retest until no leaks exist.
  - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor operation and unit operation, product capability, and compliance with requirements.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 5. Verify proper airflow over coils.
- C. Compressor and condenser units will be considered defective if they do not pass tests and inspections.
- D. Prepare test and inspection reports.

### **3.5 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
    - a. Inspect for physical damage to unit casing.
    - b. Verify that access doors move freely and are weathertight.
    - c. Clean units and inspect for construction debris.
    - d. Verify that all bolts and screws are tight.
    - e. Verify that controls are connected and operational.
- B. Lubricate bearings on fan motors.
- C. Verify that fan wheel is rotating in the correct direction and is not vibrating or binding.
- D. Start unit according to manufacturer's written instructions and complete manufacturer's startup checklist.
- E. Measure and record airflow and air temperature rise over coils.
- F. Verify proper operation of condenser capacity control device.
- G. After startup and performance test, lubricate bearings.

**3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain compressor and condenser units.

**END OF SECTION 23 62 00**  
07/10/2018



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**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 factory-packaged units capable of supplying 100 percent outdoor air and providing heating.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and attachment 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.
- C. Delegated-Design Submittal: For design of vibration isolation, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
  - 1. Unit fabrication and assembly details.
  - 2. Design Calculations:
    - a. Calculate requirements for selecting vibration isolators.
    - b. Indicate compliance with "Performance Requirements" article.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Startup service reports.
- B. Sample Warranty: For special warranty.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For units to include in emergency, operation, and maintenance manuals.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan Belts: One set for each belt-driven fan.

**1.7 WARRANTY**

- A. Special Warranty: Manufacturer agrees to replace components of units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period for Heat Exchangers: 10 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Carrier.
  - 2. Lennox.
  - 3. Trane.
  - 4. York.

**2.2 PERFORMANCE REQUIREMENTS**

- A. General Fabrication Requirements: Comply with requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment," and Section 7 - "Construction and System Start-up."
- B. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design vibration isolation.
- C. Cabinet Thermal Performance:
  - 1. Maximum Overall U-Value: Comply with requirements in ASHRAE/IESNA 90.1.
  - 2. Maximum Overall U-Value: 0.10 Btu/h x sq. ft. x deg F.
  - 3. Include effects of metal-to-metal contact and thermal bridges in the calculations.
- D. Cabinet Surface Condensation:
  - 1. Cabinet shall have additional insulation and vapor seals if required to prevent condensation on the interior and exterior of the cabinet.
- E. Maximum Cabinet Leakage: 2 percent of the total supply-air flow at a pressure rating equal to the fan shut-off pressure.
- F. Cabinet Deflection Performance:
  - 1. Walls and roof deflection shall be within 1/200 of the span at the design working pressure equal to the fan shut-off pressure. Deflection limits shall be measured at any point on the surface.
  - 2. Floor deflections shall be within 1/240 of the span considering the worst-case condition caused by the following:
    - a. Service personnel.
    - b. Internal components.
    - c. Design working pressure defined for the walls and roof.
- G. 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.

**2.3 CABINET**

- A. Construction: Double wall.
- B. Exterior Casing Material: Galvanized steel with paint finish.
- C. Interior Casing Material: Galvanized steel.
- D. Lifting and Handling Provisions: Factory-installed shipping skids and lifting lugs.

- E. Base Rails: Galvanized-steel rails for mounting on roof curb or pad as indicated.
- F. Access for Inspection, Cleaning, and Maintenance: Comply with requirements in ASHRAE 62.1.
  - 1. Service Doors: Hinged access doors with gaskets. Material and construction of doors shall match material and construction of cabinet in which doors are installed.
- G. Roof: Standing seam or membrane; sloped to drain water.
- H. Floor: Reinforced, metal surface; reinforced to limit deflection when walked on by service personnel. Insulation shall be below metal walking surface.
- I. Cabinet Insulation:
  - 1. Type: Fibrous-glass duct lining complying with ASTM C 1071, Type II
  - 2. Thickness: 1 inch, 1-1/2 lb. density.
  - 3. Insulation Adhesive: Comply with ASTM C 916, Type I.
  - 4. Mechanical Fasteners: Suitable for adhesive, mechanical, or welding attachment to casing without damaging liner and without causing air leakage when applied as recommended by manufacturer.
- J. Condensate Drain Pans:
  - 1. Shape: Rectangular, with 2 percent slope in at least two planes to direct water toward drain connection.
  - 2. Size: Large enough to collect condensate from heat exchanger.
    - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
    - b. Depth: A minimum of 2 inches deep.
  - 3. Configuration: Single wall.
  - 4. Material: Stainless-steel sheet.
  - 5. Drain Connection:
    - a. Located on one end of pan, at lowest point of pan.
    - b. Terminated with threaded nipple.
    - c. Minimum Connection Size: NPS 1.
- K. Surfaces in Contact with Airstream: Comply with requirements in ASHRAE 62.1 for resistance to mold and erosion.

## **2.4 SUPPLY FAN**

- A. Forward-Curved Fan Type: Centrifugal; statically and dynamically balanced.
  - 1. Fan Wheel Material: Galvanized steel, mounted on solid-steel shaft.
  - 2. Bearings: Self-aligning, permanently lubricated ball bearings.
- B. Service Factor for Belt Drive Applications: V-belt drive with matching fan pulley and adjustable motor sheaves and belt assembly with minimum 1.5 service factor.
- C. Motors:
  - 1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
- D. Mounting: Fan wheel, motor, and drives shall be mounted to fan casing with elastomeric isolators.

**2.5 INDIRECT-FIRED GAS FURNACE HEATING**

- A. Furnace Assembly:
  - 1. Factory assembled, piped, and wired.
  - 2. Comply with requirements in NFPA 54, "National Fuel Gas Code," and ANSI Z21.47, "Gas-Fired Central Furnaces."
  - 3. AGA Approval: Designed and certified by and bearing label of AGA.
- B. Burners:
  - 1. Heat-Exchanger Material: Stainless steel with a minimum thermal efficiency of 80 percent.
  - 2. Fuel: Natural gas.
  - 3. Ignition: Electronically controlled electric spark with flame sensor.
- C. Heat-Exchanger Drain Pan Material: Stainless steel.
- D. Venting: Power vent with integral, motorized centrifugal fan interlocked with gas valve.
- E. Safety Controls:
  - 1. Gas Control Valve: Electronic modulating.
  - 2. Gas Train: Single-body, regulated, redundant, 24-V ac gas valve assembly containing pilot solenoid valve, pilot filter, pressure regulator, pilot shutoff, and manual shutoff.

**2.6 OUTDOOR-AIR INTAKE HOOD**

- A. Type: Over/Under air intake with hood, to allow for return ductwork connection below hood to unit.
- B. Materials: Match cabinet.
- C. Bird Screen: Comply with requirements in ASHRAE 62.1.
- D. Configuration: Designed to inhibit wind-driven rain and snow from entering unit.

**2.7 FILTERS**

- A. Cleanable Filters: 1-inch- thick, cleanable metal mesh.

**2.8 ELECTRICAL POWER CONNECTIONS**

- A. General Electrical Power Connection Requirements: Factory-installed and -wired switches, motor controllers, transformers, and other necessary electrical devices shall provide a single-point field power connection to unit.
- B. Enclosure: NEMA 250, Type 3R, mounted in unit with hinged access door in unit cabinet having a lock and key or padlock and key,
- C. Wiring: Numbered and color-coded to match wiring diagram.
- D. Wiring Location: Install factory wiring outside an enclosure in a raceway.
- E. Power Interface: Field power interface shall be to a fused disconnect switch.
- F. Factory Wiring: Branch power circuit to each motor and to controls shall terminate at terminal block.
- G. Factory-Mounted, Overcurrent-Protection Service: For each motor.

- H. Transformer: Factory mounted with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- I. Controls: Factory wire unit-mounted controls where indicated.
- J. Control Relays: Auxiliary and adjustable time-delay relays.

**2.9 CONTROLS**

- A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations."
- B. Control Wiring: Factory wire connection for controls power supply.
- C. Control Devices: Sensors, transmitters, relays, switches, detectors, operators, actuators, and valves shall be manufacturer's standard items to accomplish indicated control functions.
- D. Control Dampers:
  - 1. Damper Location: Factory installed inside unit for ease of blade axle and bushing service. Arrange dampers located in a mixing box to achieve convergent airflow to minimize stratification.
  - 2. Damper Leakage: Comply with requirements in AMCA 500-D. Leakage shall not exceed 6.5 cfm per sq. ft. at a static-pressure differential of 4.0 inches water column when a torque of 5 inch pounds per sq. ft. is applied to the damper jackshaft.
  - 3. Damper Rating: Rated for close-off pressure equal to the fan shutoff pressure.
  - 4. Damper Label: Bear the AMCA seal for both air leakage and performance.
  - 5. Blade Configuration: Unless otherwise indicated, use parallel blade configuration for two-position control and equipment isolation service and use modulating control when mixing two airstreams. For other applications, use an opposed-blade configuration.
  - 6. Damper Frame Material: Galvanized steel.
  - 7. Blade Type: Single-thickness metal reinforced with multiple V-grooves or hollow-shaped airfoil.
  - 8. Blade Material: Galvanized steel.
  - 9. Maximum Blade Width: 6 inches.
  - 10. Maximum Blade Length: 48 inches.
  - 11. Blade Seals: Replaceable, continuous perimeter vinyl seals and jambs with stainless-steel compression-type seals.
  - 12. Bearings: Thrust bearings for vertical blade axles.
- E. Damper Operators:
  - 1. Factory-installed electric operator for each damper assembly with one operator for each damper assembly mounted to the damper frame.
  - 2. Operator capable of shutoff against fan pressure and able to operate the damper with sufficient reserve power to achieve smooth modulating action and proper speed of response at the velocity and pressure conditions to which the damper is subjected.
  - 3. Maximum Operating Time: Open or close damper 90 degrees in 60 seconds.
  - 4. Adjustable Stops: For both maximum and minimum positions.
  - 5. Position Indicator and Graduated Scale: Factory installed on each actuator with words "OPEN" and "CLOSED," or similar identification, at travel limits.
  - 6. Spring-return operator to fail-safe; either closed or open as required by application.
  - 7. Operator Type: Direct coupled, designed for minimum 60,000 full-stroke cycles at rated torque.
  - 8. Position feedback Signal: For remote monitoring of damper position.
  - 9. Coupling: V-bolt and V-shaped, toothed cradle.
  - 10. Circuitry: Electronic overload or digital rotation-sensing circuitry.
- F. Furnace Controls:
  - 1. Electromechanical or Electronic Burner Control: 20 to 100 percent modulation of the firing rate.

- G. Interface with DDC System for HVAC: Factory-installed hardware and software to enable the DDC system for HVAC to monitor, control, and display unit status and alarms.
  - 1. ASHRAE 135 (BACnet) communication interface with the DDC system for HVAC shall enable the DDC system for HVAC operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the DDC system for HVAC.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping, ducts, and electrical systems to verify actual locations of connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 INSTALLATION**

- A. Comply with manufacturer's rigging and installation instructions for unloading units and moving to final locations.
- B. Equipment Mounting:
  - 1. Install air units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033100 "Site Cast-in-Place Concrete."
  - 2. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Systems."
- C. Comply with requirements for gas-fired furnace installation in NFPA 54, "National Fuel Gas Code."

#### **3.3 CONNECTIONS**

- A. Where installing piping adjacent to units, allow space for service and maintenance.
- B. Gas Piping Connections:
  - 1. Comply with requirements in Section 231123 "Facility Natural-Gas Piping."
  - 2. Connect gas piping to furnace, full size of gas train inlet, and connect with union, pressure regulator, and shutoff valve with sufficient clearance for burner removal and service.
  - 3. Install AGA-approved flexible connectors.
- C. Duct Connections:
  - 1. Comply with requirements in Section 233113 "Metal Ducts."
  - 2. Drawings indicate the general arrangement of ducts.
  - 3. Connect ducts to units with flexible duct connectors. Comply with requirements for flexible duct connectors in Section 233300 "Air Duct Accessories."
- D. Electrical Connections: Comply with requirements for power wiring, switches, and motor controls in electrical Sections.
  - 1. Install electrical devices furnished by unit manufacturer but not factory mounted.

### 3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.
  - 2. Inspect units for visible damage to furnace combustion chamber.
  - 3. Perform the following operations for both minimum and maximum firing and adjust burner for peak efficiency:
    - a. Measure gas pressure at manifold.
    - b. Measure combustion-air temperature at inlet to combustion chamber.
    - c. Measure flue-gas temperature at furnace discharge.
    - d. Perform flue-gas analysis. Measure and record flue-gas carbon dioxide and oxygen concentration.
    - e. Measure supply-air temperature and volume when burner is at maximum firing rate and when burner is off. Calculate useful heat to supply air.
  - 4. Inspect casing insulation for integrity, moisture content, and adhesion.
  - 5. Verify that clearances have been provided for servicing.
  - 6. Verify that controls are connected and operable.
  - 7. Verify that filters are installed.
  - 8. Clean furnace flue and inspect for construction debris.
  - 9. Inspect operation of power vents.
  - 10. Purge gas line.
  - 11. Inspect and adjust vibration isolators.
  - 12. Verify bearing lubrication.
  - 13. Clean fans and inspect fan-wheel rotation for movement in correct direction without vibration and binding.
  - 14. Adjust fan belts to proper alignment and tension.
  - 15. Start unit.
  - 16. Inspect and record performance of interlocks and protective devices including response to smoke detectors by fan controls and fire alarm.
  - 17. Operate unit for run-in period.
  - 18. Calibrate controls.
  - 19. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
  - 20. Verify operational sequence of controls.
  - 21. Measure and record the following airflows. Plot fan volumes on fan curve.
    - a. Supply-air volume.
    - b. Return-air flow.
    - c. Outdoor-air flow.
- B. After startup, clean filters, verify bearing lubrication, and adjust belt tension.
- C. Remove and replace components that do not properly operate and repeat startup procedures as specified above.
- D. Prepare written report of the results of startup services.

### 3.5 ADJUSTING

- A. Adjust initial temperature set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.



**3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION 23 74 33**  
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**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 split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
  - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Wiring Diagrams: For power, signal, and control wiring.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

**1.6 QUALITY ASSURANCE**

- 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 application.
- B. ASHRAE Compliance:
  - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
  - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Procedures," and Section 7 - "Construction and System Start-up."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- D. ANSI/ASHRAE/IESNA Standard 90.1 Compliance: Equipment shall meet or exceed the minimum efficiency requirements of the standard. Equipment shall bear a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE Standard 90.1.

**1.7 COORDINATION**

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033100 "Site Cast-in-Place Concrete."

**1.8 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period:
    - a. For Compressor: Five years from date of Substantial Completion.
    - b. For Parts: One year from date of Substantial Completion.
    - c. For Labor: One year from date of Substantial Completion.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. LG.
  - 2. Mitsubishi Electric & Electronics USA, Inc.
  - 3. SANYO North America Corporation.

**2.2 INDOOR UNITS (5 TONS OR LESS)**

- A. Ceiling-Recessed Evaporator-Fan Components:
  - 1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
  - 2. Insulation: Faced, glass-fiber duct liner.
  - 3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
  - 4. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
  - 5. Fan Motors:
    - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
    - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
    - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
  - 6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
  - 7. Filters: Permanent, cleanable.
  - 8. Condensate Drain Pans:
    - a. Fabricated with two percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends), and to direct water toward drain connection.
      - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
      - 2) Depth: A minimum of 2 inches deep.

- b. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
- c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
  - 1) Minimum Connection Size: NPS 1.
- d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

### **2.3 OUTDOOR UNITS (5 TONS OR LESS)**

#### **A. Air-Cooled, Compressor-Condenser Components:**

- 1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
- 2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
  - a. Compressor Type: Scroll.
  - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
  - c. Refrigerant Charge: R-410A.
  - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
- 3. Fan: Aluminum-propeller type, directly connected to motor.
- 4. Motor: Permanently lubricated, with integral thermal-overload protection.
- 5. Wind Baffle: Permits operation down to 0 deg F.

### **2.4 ACCESSORIES**

- A. Sequence of operation are specified in Section 230993.11 "Sequence of Operations for HVAC DDC."
- B. Wired Thermostat: Low voltage with subbase to control compressor and evaporator fan.
- C. Automatic-reset timer to prevent rapid cycling of compressor.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Equipment Mounting:
  - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033100 "Site Cast-in-Place Concrete".
  - 2. Suspend ceiling recessed evaporator-fan components with elastomeric hangers.
  - 3. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Systems."

**3.2 CONNECTIONS**

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.

**3.3 FIELD QUALITY CONTROL**

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

**3.4 STARTUP SERVICE**

- A. Engage a factory-authorized service representative to perform startup service.
  - 1. Complete installation and startup checks according to manufacturer's written instructions.

**3.5 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain units.

**END OF SECTION 23 81 26**  
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## **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. This Section includes fan-coil units and accessories.

### **1.3 DEFINITIONS**

- A. BAS: Building automation system.

### **1.4 ACTION SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 1. Wiring Diagrams: Power, signal, and control wiring.

### **1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01, include the following:
  - 1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

### **1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan-Coil-Unit Filters: Furnish one spare filter for each filter installed.

### **1.7 QUALITY ASSURANCE**

- A. 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 intended use.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

### **1.8 COORDINATION**

- A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

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**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings, or comparable product by one of the following:
1. International Environmental Corporation.
  2. Johnson Controls, Incorporated.
  3. Price Industries.
  4. Trane.

**2.2 DUCTED FAN-COIL UNITS**

- A. Description: Factory-packaged and -tested units rated according to ARI 440, ASHRAE 33, and UL 1995.
- B. Coil Section Insulation: 1-inch thick foil-faced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
  2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Drain Pans: Stainless steel. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- D. Chassis: Galvanized steel and removable access panels.
- E. Cabinets: Steel.
1. Mixing Plenum Box: Sheet metal plenum finished and insulated to match the chassis with outdoor- and return-air, formed-steel dampers.
  2. Dampers: Low leakage galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.
- F. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Two-inch, MERV 8.
- G. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.
- H. Refrigerant Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, and brazed joints at fittings. Comply with ARI 210/240, and leak test to minimum 450 psig for a minimum 300 psig working pressure. Include thermal expansion valve.
- I. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, direct current, multispeed ECM motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- J. Control devices and operational sequences are specified in Section 230900 "Instrumentation and Control for HVAC" and "Sequence of Operation for HVAC Control." As described on plans.

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**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install fan-coil units level and plumb.
- B. Install fan-coil units to comply with NFPA 90A.
- C. Suspend horizontal fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Section 230548 "Vibration and Seismic Controls for HVAC Systems."
- D. Vertical Fan-Coil Units:
  - 1. Install vertical fan-coil units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-In-Place Concrete."
  - 2. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC Systems."
- E. Verify locations of thermostats and other exposed control sensors with Drawings and room details before installation. Install devices at a height above finished floor as determined by the Architect and or Engineer.
- F. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

**3.3 CONNECTIONS**

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  - 1. Install piping adjacent to machine to allow service and maintenance.
  - 2. Connect piping to fan-coil-unit.
- B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

**3.4 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections and prepare test reports:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.



**3.5 ADJUSTING**

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

**3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 for additional requirements.

**END OF SECTION 23 82 19**  
07/10/2018

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**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes hydronic convectors.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and 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. Indicate location and size of each field connection.
  - 4. Indicate location and arrangement of piping valves and specialties.
  - 5. Include enclosure joints, corner pieces, access doors, and other accessories.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Color Samples for Initial Selection: For units with factory-applied color finishes. Color selection by Architect.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

**PART 2 - PRODUCTS**

**2.1 HOT-WATER CONVECTORS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Airtherm; a Mestek company.
  - 2. Rosemex Products.
  - 3. Sterling HVAC Products; a Mestek company.
  - 4. Vulcan Radiator; a Mestek company.
  - 5. Zehnder Rittling.
- B. Heating Elements: Seamless copper tubing mechanically expanded into evenly spaced aluminum fins and rolled into cast-iron or brass headers with inlet/outlet and air vent; steel side plates and supports. Factory-pressure-test element at minimum 100 psig.
- C. Front and Top Panel: 14-gauge thick steel with exposed corners rounded; removable front panels with tamper-resistant fasteners braced and reinforced for stiffness.
- D. Wall-Mounted Back and End Panels: Minimum 0.0428-inch- thick steel.

- E. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.
- F. Insulation: 1/2-inch- thick, fibrous glass on inside of the back of the enclosure.
- G. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
- H. Access Doors: Factory made, permanently hinged with tamper-resistant fastener, minimum size 6 by 7 inches, integral with enclosure.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine areas to receive convectors for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic-piping to verify actual locations before installation of convector.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install convectors level and plumb.
- B. Install valves within reach of access door provided in enclosure.
- C. Install air-seal gasket between wall and recessed flanges or front cover of fully recessed unit.

**3.3 CONNECTIONS**

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot-water convectors and components to piping according to Section 232113 "Hydronic Piping."
  - 1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.
- C. Install control valves as required by Section 230900.
- D. Install piping adjacent to convectors to allow service and maintenance.

**3.4 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections:
  - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Convectors will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

**END OF SECTION 23 82 33**  
07/10/2018

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section includes hydronic, finned-tube radiation heaters.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and 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. Indicate location and size of each field connection.
  - 4. Indicate location and arrangement of piping valves and specialties.
  - 5. Include access doors and other accessories.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Color Samples for Initial Selection: For finned-tube radiation heaters with factory-applied color finishes. Color selection by Architect.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

**PART 2 - PRODUCTS**

**2.1 HOT-WATER BASEBOARD RADIATION HEATERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Airtherm; a Mestek company.
  - 2. Rosemex Products.
  - 3. Sterling HVAC Products; a Mestek company.
  - 4. Vulcan Radiator; a Mestek company.
  - 5. Zehnder Rittling.
- B. Performance Ratings: Rate baseboard radiation heaters according to Hydronics Institute's "I=B=R Testing and Rating Standard for Baseboard Radiation."
- C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on polypropylene element glides. One end of tube shall be belled.
- D. Enclosures: 18-gauge steel, removable front cover.
  - 1. Full-height back.

2. End panel.
3. End caps.
4. Inside and outside corners.
5. Valve access door.
6. Joiner pieces to snap together.
7. Finish: Baked-enamel finish in manufacturer's standard color as selected by Architect.
8. Element Brackets: Primed and painted steel to support front panel and element.

### **PART 3 - EXECUTION**

#### **3.1 EXAMINATION**

- A. Examine areas to receive finned-tube radiation heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic-piping connections to verify actual locations before installation of finned-tube radiation heaters.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.2 BASEBOARD RADIATION HEATER INSTALLATION**

- A. Install units level and plumb.
- B. Install access doors for access to valves.
- C. Terminate enclosures with manufacturer's end caps.
- D. Install valves within reach of access door provided in enclosure.

#### **3.3 CONNECTIONS**

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect hot-water finned-tube radiation heaters and components to piping according to Section 232113 "Hydronic Piping."
  1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.
- C. Install control valves as required by Section 230900.
- D. Install piping adjacent to finned-tube radiation heaters to allow service and maintenance.

#### **3.4 FIELD QUALITY CONTROL**

- A. Perform the following field tests and inspections:
  1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
  2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.

- C. Prepare test and inspection reports.

**END OF SECTION 23 82 36**  
07/10/2018

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**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 propeller unit heaters with hot-water coils.

**1.3 DEFINITIONS**

- A. CWP: Cold working pressure.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
  - 1. Include plans, elevations, sections, and 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. Include location and size of each field connection.
  - 4. Include details of anchorages and attachments to structure and to supported equipment.
  - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
  - 6. Indicate location and arrangement of piping valves and specialties.
  - 7. Indicate location and arrangement of integral controls.
  - 8. Wiring Diagrams: Power, signal, and control wiring.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

**1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Airtherm; a Mestek company.
  - 2. Rosemex Products.
  - 3. Sterling HVAC Products; a Mestek Company.
  - 4. Trane.
  - 5. Vulcan Radiator; a Mestek Company.
  - 6. Zehnder Rittling.



**2.2 DESCRIPTION**

- A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- 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 application.

**2.3 PERFORMANCE REQUIREMENTS**

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

**2.4 HOUSINGS**

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Discharge Louver: Adjustable fin diffuser for horizontal units.

**2.5 COILS**

- A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
- B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

**2.6 FAN AND MOTOR**

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated, multispeed. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."

**2.7 CONTROLS**

- A. Control Devices:
  - 1. Unit-mounted thermostat.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 INSTALLATION**

- A. Install propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.
- C. Suspend propeller unit heaters from structure with all-thread hanger rods and elastomeric hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC Systems."

**3.3 CONNECTIONS**

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Comply with safety requirements in UL 1995.
- D. Unless otherwise indicated, install union and ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping."
- E. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

**3.4 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

**3.5 ADJUSTING**

- A. Adjust initial temperature set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

**3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

**END OF SECTION 23 82 39.16**  
07/10/2018

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**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. This section is intended to supplement the requirements of Division 01 requirements. For any conflicting requirements for minimum quantities or quality levels between this Section and Division 01, comply with the most stringent requirement.

**1.2 SUMMARY**

- A. This Section includes the following when associated with Divisions 26, 27, and 28 work:
  - 1. Permits and fees, code requirements, work under other contracts.
  - 2. Work restrictions.
  - 3. Specification formats and conventions.
  - 4. Request for information.
  - 5. Coordination.
  - 6. Conflicting requirements.
  - 7. Quality assurance and control.
  - 8. Product delivery, storage, and handling.
  - 9. Product warranties.
  - 10. Submittals.
  - 11. Product selection procedures.
  - 12. Product interoperability requirements.
  - 13. General execution of project scope of work.
  - 14. Record drawings.
  - 15. Demonstration and training.

- B. Related Sections include the following:
  - 1. Division 01 Sections.

**1.3 PERMITS AND FEES**

- A. Give all necessary notices, obtain all permits; pay all government and state sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Project scope of 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 inspections for Project scope of work and deliver a copy to the Architect/Engineer before request for acceptance and final payment for the Project scope of work.

**1.4 CODE REQUIREMENTS**

- A. Project Code: Confirm the codes in effect at the time of permitting.
- B. Project Legislative Requirements: Confirm the State and Local Legislations in effect at the time of permitting or those that affect construction.
- C. Compliance: Comply with all codes and legislations applicable to the project, including energy related:
  - 1. Means and Methods
  - 2. Equipment and Devices.
  - 3. Materials and Work Product.

**1.5 WORK UNDER OTHER CONTRACTS**

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

**1.6 WORK RESTRICTIONS**

- A. Existing Utility Interruptions: 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:
  - 1. Notify Construction Manager or Owner not less than 10 days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Construction Manager's or Owner's written permission.

**1.7 REQUESTS FOR INFORMATION (RFIs)**

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
  - 1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
  - 1. Project name.
  - 2. Project number.
  - 3. Date.
  - 4. Name of Contractor.
  - 5. Name of Engineer, Architect and Construction Manager.
  - 6. RFI number, numbered sequentially.
  - 7. RFI subject.
  - 8. Specification Section number and title and related paragraphs, as appropriate.
  - 9. Drawing number and detail references, as appropriate.
  - 10. Field dimensions and conditions, as appropriate.
  - 11. Contractor's suggested resolution.
  - 12. Contractor's signature.
  - 13. Attachments: Include sketches, descriptions, measurements, photos, product data, shop drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. The following RFIs will be returned without action:
  - 1. Requests for approval of submittals.
  - 2. Requests for approval of substitutions.
  - 3. Requests for coordination information already indicated in the Contract Documents.
  - 4. Requests for adjustments in the Contract Time or the Contract Sum.
  - 5. Requests for interpretation of Architect's actions on submittals.
  - 6. Incomplete RFIs or inaccurately prepared RFIs.
- D. Action may include a request for additional information, in which case time for response will date from time of receipt of additional information.

**1.8 COORDINATION**

- A. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.

**1.9 CONFLICTING REQUIREMENTS**

- A. General: If compliance with two or more standards or directives is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

**1.10 MINOR CHANGES IN THE WORK**

- A. Engineer/Architect will issue through the Construction Manager, supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.
- B. Drawings are diagrammatic, the Contractor shall relocate devices a reasonable distance for coordination.
  - 1. A reasonable distance is considered to be 15 feet at no additional cost.

**1.11 QUALITY ASSURANCE AND CONTROL**

- A. General: Qualifications paragraphs in this Article establish some of the minimum qualification levels required; Division 01 and individual Specification Sections specify additional requirements.
- B. Code Compliance: Work and equipment shall comply with all latest applicable codes and legislations.
- C. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those required for this Project.
- D. Instructor Qualifications: A factory-authorized service representative, complying with requirements in "Quality Requirements," experienced in operation and maintenance procedures and training.
- E. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

- a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
- 2. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
- 3. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- F. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.
- G. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- H. **Associated Services:** Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Delivery of samples to testing agencies.
  - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- I. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- J. **Compatibility of Options:** If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
  - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
  - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used at no additional cost to the project.
- K. **Acceptance of Work:** 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 Code, Legislation, the Drawings and/or Specifications. Correct Work not in conformance whenever non-conformance is discovered.

**1.12 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions and generally accepted construction practice.
- B. **Storage:**
  - 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

**1.13 PRODUCT WARRANTIES**

- A. Refer to Division 01 and individual sections for requirements.
- B. The following requirements are supplemental and in addition to those stated in other specific sections and Division 01.
  1. Warranty all materials and workmanship under these Specifications and the Contract for a period of one year from the date of final acceptance by the Owner.
  2. During this warranty period, correct or replace all defects developing through materials or workmanship immediately as directed by the Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction.
- C. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- D. Warranty Start Date: From the date of final acceptance by the Owner.

**1.14 SUBMITTAL PROCEDURES**

- A. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
  1. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
- C. Substitution Requests: Submit four copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  1. Substitution: A submittal shall be considered a substitution when the Engineer/Architect does not accept the product or material as an "equivalent" or where one of the listed manufacturers is not submitted.
  2. Substitution Requirements: Substitutions shall meet the requirements of "Comparable Products."
  3. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified material or product cannot be provided.
    - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.



- c. Detailed comparison of significant qualities of proposed substitution with those of the Project scope of work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
- e. Samples, where applicable or requested.
- f. Cost information, including a proposal of change, if any, in the Contract Sum.
- g. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
- h. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- i. Statement indicating why the requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations.

#### **1.15 RECORD DRAWINGS AND RECORD DIGITAL FILES**

A. Record Drawings and Record Digital Files: Comply with the following:

1. Submit Record Drawings and Record Digital Files as follows:

- a. Initial Submittal: Submit one set of plots from corrected Record CAD Drawings and one set of marked-up Record Prints. Engineer will initial and date each plot and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. Engineer will return plot for organizing into sets, printing, binding, and final submittal.
- b. Final Submittal: Submit one set of marked-up Record Prints.
- c. Final Submittal: Submit three sets of Record CAD Drawing files and one set of Record CAD Drawing plots. Plot and print each drawing, whether or not changes and additional information were recorded.

1) Electronic Media: CD-R.

B. Qualification Data: For training instructor.

#### **1.16 PRODUCT SELECTION PROCEDURES**

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer and/or Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
6. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

1. Design Basis: The design has been based on the single manufacturer indicated in the contract documents. The Contractor is responsible for verifying prior to submission, that any other manufacturer even though listed complies with dimensional and performance characteristics of the

base specified product. Modifications shall be made by the Contractor as part of this contract to accommodate changes to the design basis.

2. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
3. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
4. Equivalent Product: Equipment, material or devices submitted for review as an "accepted equivalent" shall meet all of the following requirements:
  - a. A product of a listed manufacturer.
  - b. The equivalent shall have the same construction features such as, but not limited to:
    - 1) Material thickness, gauge, weight, density, etc.
    - 2) Welded, riveted, bolted, etc., construction
    - 3) Finish, undercoating, corrosion protection
  - c. The equivalent shall perform with the same or better operating efficiency.
  - d. The equivalent shall have equal or greater reserve capacity.
  - e. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  - f. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL, AMCA or ARI labels.

#### **1.17 PRODUCT INTEROPERABILITY REQUIREMENTS**

- A. Interoperability Coordination Meeting: Attend a minimum of 3 weekly coordination meetings to coordinate interoperability between all systems and equipment. Meetings shall be scheduled by the construction manager.
- B. General Networking and Protocol Interoperability Requirements: Provide products that are fully BACNet interoperable.
  1. All systems and equipment shall interface with the primary building management network provided under "Instrumentation and Controls for HVAC" using Ethernet standards and BACNet protocol.
  2. Equipment that is native BACNet may connect directly to a BACNet MS/TP subnet that is provided by "Instrumentation and Controls for HVAC" when coordinated with that Section Contractor.
  3. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to the most current ANSI/ASHRAE Standard 135, BACnet.
  4. The MS/TP trunks support all of the ASHRAE 135 approved baud rates.
  5. All MS/TP devices support all baud rates of the ASHRAE 135.
  6. All MS/TP devices shall be BTL approved ( BACnet Testing Lab).
  7. All BACnet routers must support B-BC (BIBB) and support BBMD routing.
  8. Lonworks and Modbus subnets may be utilized where no BACNet protocol is available provided full 2-way compatibility is provided through a gateway.
    - a. Exception: Fire alarm systems shall be 1-way, read only communication.
  9. Each individual system and/or equipment manufacturer/installer shall provide all necessary gateways/translators Provide Gateway with all products as required facilitating full BACNet interoperability with BACNet Protocol.
  10. It must be possible to read and display the value of any property, including all required properties, supported optional properties, and proprietary extensions of very object of every networked device.
  11. Operating setpoints and parameters must be available for modification via BACnet services via a graphical user interface (GUI).
  12. An operator shall be able to display at any time the operational status of any device on the BACnet internetwork. An operator shall be able to display at any time any property of any BACnet object. An operator shall also be able to display property values of objects grouped by object type, object location, building system, and by user defined parameters.
  13. An operator shall have the ability to issue re-initialization commands to any device that supports remote re-initialization.

14. An operator shall have the ability to backup and restore all BACnet devices on the network.
  15. It shall be each contractor's responsibility to configure each router using the network numbering scheme for the project. Each router shall be configured such that all network layer error messages shall be directed to a specific workstation using the BACnet Confirmed Text Message service. It shall be the contractor's responsibility to initially configure each router with routing tables containing all network numbers that are part of the project's internet. The router shall be able to receive messages at each port of any length that is valid for the LAN technology connected to that port, and to forward the message to any directly-connected network that can convey a message of that size.
  16. Legacy Systems: Bi-directional gateways shall be provided for systems and equipment operating on a legacy/proprietary system. The operator workstation shall display information from both the BACnet and non-BACnet devices. Any information specified or required for system functionality shall be made readable and modifiable. Gateways shall have 10% expansion capacity. Gateways shall support archiving, uploading, trending, scheduling, and alarm/event detection, notification and acknowledgement.
  17. Systems and equipment shall have full 2- way communications and interoperability.
    - a. Exception: Fire safety systems and equipment shall have only read access to outside systems:
      - 1) Fire alarm.
  18. Coordinate with "Instrumentation and Controls for HVAC" and other building operational systems for specific interoperability requirements.
- C. Communications Standard: Coordinate communications standards requirements with other Sections and Divisions.
1. MS/TP LAN: RS 485
  2. Systems with dedicated network(s) shall connect on the BACNet Ethernet LAN: utilizing a switch and shall meet standard Ethernet requirements.
    - a. Utilize RJ-45 terminations.
    - b. Utilize CAT 6 cabling.
    - c. Meet IEEE Standard 802.3 standards and requirements.
    - d. Speed: 100 Mbps.
  3. Equipment without dedicated networks shall connect to the BACNet MS/TP LAN.
    - a. RS 485 communications standard.
    - b. Speed: 1 Mbps.
- D. Information Availability: Make all product information, points, variables, setpoints, etc., available for access of building operational systems upon request.
1. Provide bi-directional point mapping/addressing instructions.
  2. Provide on-site technicians as required to ensure proper information exchange.
- E. Factory Provided Equipment Controllers: Provide all information, points, variables, setpoints, etc., indicated and referenced in all documentation, including "Instrumentation and Controls for HVAC." Products shall have full interoperability as indicated in this Section, in BACNet standards and elsewhere.

## **PART 2 - PRODUCTS**

### **2.1 SHOP DRAWINGS**

- A. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed or electronic data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
  - a. Identification of products.
  - b. Schedules.
  - c. Compliance with specified standards.
  - d. Notation of coordination requirements.
  - e. Notation of dimensions established by field measurement.
  - f. Relationship and attachment to adjoining construction clearly indicated.
  - g. Seal and signature of professional engineer if specified.
2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

## **2.2 RECORD DRAWINGS**

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
  1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an understandable drawing technique.
    - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Revisions to details shown on Drawings.
    - b. Locations and depths of underground system entities.
    - c. Revisions to routing of piping.
    - d. Actual equipment locations.
    - e. Duct size and routing.
    - f. Locations of concealed internal utilities.
    - g. Changes made by Change Order or Change Directive.
    - h. Changes made following Engineer's written orders.
    - i. Details not on the original Contract Drawings.
    - j. Field records for variable and concealed conditions.
    - k. Record information on the Project scope of work that is shown only schematically.
  3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  4. Mark record sets with erasable, colored pencil. Use multiple colors to distinguish between changes for different categories of the Work at same location.
  5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record CAD Drawings: Immediately before observation for Certificate of Substantial Completion, review marked-up Record Prints with Engineer and Construction Manager. When authorized, prepare a full set of corrected CAD Drawings of the Contract Drawings, as follows:
  1. Format: DWG or Revit format of the same version, and operating system as the original Contract Drawings.
  2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.

3. Refer instances of uncertainty to Engineer for resolution.
4. Contractor may request one set of CAD Drawings of the Contract Drawings for use in recording information.
  - a. Engineer makes no representations as to the accuracy or completeness of CAD Drawings as they relate to the Contract Drawings.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
  1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Record CAD/Revit Drawings: Organize information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each file.
  3. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Engineer, Architect and Construction Manager.
    - e. Name of Contractor.

### 2.3 RECORDING AND MAINTENANCE

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

### 2.4 TRAINING AND INSTRUCTION PROGRAM

- A. Program Structure: In addition to Division 01 and individual section requirements, develop an instruction program that includes individual training modules for each system and equipment not part of a system.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. Provide instruction for the following modules.
  1. Basis of System Design and Operational Requirements
  2. Documentation
  3. Emergencies
  4. Adjustments
  5. Troubleshooting
  6. Maintenance
  7. Repairs
- C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

## 2.5 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Engineer/Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer/Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utility and system connections.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
  3. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Written Report: Where a written report listing conditions detrimental to performance of the Project scope of work is required by other Sections, include the following:
    - a. Description of the Work.
    - b. List of detrimental conditions, including substrates.
    - c. List of unacceptable installation tolerances.
    - d. Recommended corrections.
  2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

**3.2 PREPARATION**

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

**3.3 DEMOLITION**

- A. Work indicated to be removed includes removal of all auxiliary materials, accessories, anchorage, fasteners, and etc., down to bare substrate. No residual materials shall remain from work to be removed. Contractor will use whatever means necessary; including removal of all materials attached or related to those items designated to be removed, as acceptable to Owner and Engineer, to provided complete and thorough removal of existing work.
- B. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.
- D. Abandoned Work: Cut and remove buried MEP system materials, equipment, raceways, piping and distribution, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
- E. Remove demolished materials from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Field verify all existing MEP system materials, equipment, raceways, piping and distribution to be removed for exact quantities.
- H. Remove all existing MEP system materials, equipment, raceways, piping and distribution located above ceilings and in walls that are not being reused.
- I. Remove all MEP systems and appurtenances, which are to be removed, in their entireties back to the source or source panels.
- J. Remove all existing MEP system materials, equipment, raceways, piping and distribution located in walls or ceilings being demolished. Abandon no devices that have been disconnected unless specifically noted.
- K. Maintain continuity of all existing MEP devices, and utilization equipment not removed.
- L. Remove, store, protect, and reinstall existing work as required to accommodate alteration indicated.

- M. The existing work to be removed, in general, is as indicated on the Drawings and in this Section, but also includes any materials or work necessary to permit installation of new materials, as approved by Owner and Engineer.
- N. Disconnect, demolish, and remove systems, equipment, and components indicated to be removed, abandoned or as made obsolete by this project.
  - 1. To Be Removed: Remove portion of systems, equipment, and components indicated to be removed and cap or plug remaining with same or compatible material.
  - 2. To Be Abandoned in Place: Drain piping and cap or plug systems, equipment, and components with same or compatible material.
  - 3. Equipment to Be Removed: Disconnect, make safe and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect, make safe and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect, make safe and cap services and remove equipment and deliver at direction of Owner.
- O. If systems, equipment, and components to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
- P. In finished areas, all systems, equipment, and components shall be cut back to a concealed location, i.e., within walls, above ceilings, etc., before capping.

### **3.4 INSTALLATION**

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
  - 4. Maintain minimum headroom clearance as indicated by Architect and/or Construction Manager in spaces without a suspended ceiling.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
  - 1. All electrical equipment and piping not supported from the building structural steel shall not exceed a combined load of 7 psf when supported from the metal deck/slab. Any condition that may exceed this limit shall be reviewed and approved by the Design-Builder and Structure Engineer before installation.



2. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer and/or to allow for proper access.
  3. Allow for building movement, including thermal expansion and contraction.
  4. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

**3.5 CUTTING AND PATCHING**

- A. See Division 01 for additional requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of Work.
- B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed, where wall or floors are existing or not correctly located. The Contractor shall do all drilling required for the installation of hangers.
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

**3.6 SCAFFOLDING, RIGGING, HOISTING**

- A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

**3.7 EXCAVATION AND BACKFILLING**

- A. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division.

**3.8 ACCESSIBILITY AND ACCESS PANELS**

- A. The Contractor shall be responsible for the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the Work.
- B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Access doors in walls, ceilings, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.

- D. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- E. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.

**3.9 STARTING AND ADJUSTING**

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect field-assembled components and equipment installation, comply with qualification requirements in "Quality Requirements."

**3.10 PROTECTION OF INSTALLED CONSTRUCTION**

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.
- C. Remove debris from concealed spaces before enclosing the space.
- D. Remove liquid spills promptly.
- E. Where dust would impair proper execution of the Project scope of work, broom-clean or vacuum the entire work area, as appropriate.
- F. Installed Work: Keep installed work clean.
- G. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

**3.11 CORRECTION OF THE WORK**

- A. The cost of corrective work shall be included under the contract.

- B. Repair or remove and replace defective construction.
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- C. Restore permanent facilities used during construction to their specified or original condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components to new condition.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

**END OF SECTION 26 00 10**  
07/10/2018

## **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. Building wires and cables rated 600 V and less.
  - 2. Connectors, splices, and terminations rated 600 V and less.
- B. Related Requirements:
  - 1. Section 260523 "Control-Voltage Electrical Power Cables" for control systems communications cables and Classes 1, 2 and 3 control cables.
  - 2. Section 280514 "Conductors and Cables for Fire Alarm" for cabling used for fire alarm circuit.

### **1.3 DEFINITIONS**

- A. EPDM: Ethylene-propylene-diene terpolymer rubber.
- B. NBR: Acrylonitrile-butadiene rubber.
- C. VFC: Variable frequency controller.

### **1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

### **1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For testing agency.
- B. Field quality-control reports.

### **1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

## **PART 2 - PRODUCTS**

### **2.1 GENERAL REQUIREMENTS**

- A. Comply with the requirements in Part 3 Articles for where materials shall be applied.

### **2.2 CONDUCTORS AND CABLES**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Alpha Wire Company.

2. American Insulated Wire Corp.
3. Belden Inc.
4. Cerro Wire LLC.
5. Encore Wire Corporation.
6. General Cable Technologies Corporation.
7. General Cable; General Cable Corporation.
8. Senator Wire & Cable Company.
9. Southwire Company.

- B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.
- C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2 and Type XHHW-2.
- D. Low Leakage Conductor: Type.
- E. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with insulated equipment ground conductor.
  1. Cable shall be steel clad. "MC-Lite" cable will not be permitted.

### 2.3 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. 3M.
  2. AFC Cable Systems, Inc.
  3. Gardner Bender.
  4. Hubbell Power Systems, Inc.
  5. Ideal Industries, Inc.
  6. ILSCO.
  7. NSi Industries LLC.
  8. O-Z/Gedney; an EGS Electrical Group brand; an Emerson Industrial Automation business.
  9. Tyco Electronics Corp.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

### 2.4 SYSTEM 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 application.
- B. Comply with NFPA 70.

## PART 3 - EXECUTION

### 3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.
- B. Branch Circuits: Copper. Solid for No. 12 AWG and smaller; stranded for No. 10 AWG and larger.

### 3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Exposed Feeders: Type THHN/THWN-2, single conductors in raceway.

- B. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- D. Branch Circuits Concealed in Ceilings, Walls and Partitions: Type THHN/THWN, single conductors in raceway to outlet box located within 10 ft. of first wiring device, luminaire or utilization equipment indicated on documents served by branch circuit. Metal-clad cable, Type MC may be used on load side of this outlet box.
- E. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.
- F. Class 1 Control Circuits: Type THHN/THWN, in raceway.
- G. Class 2 Control Circuits: Type THHN/THWN, in raceway.
- H. Minimum Branch Circuit Conductor Size: No. 12 AWG. For all 120-volt circuits in excess of 100 ft. from power source to last device, provide No. 10 AWG entire length of circuit. For all 120-volt circuits in excess of 200 ft. from power source to last device, provide No. 8 AWG entire length of circuit. For all 208-volt circuits in excess of 200 ft. from power source to last device, provide No. 10 AWG entire length of circuit.
- I. VFC Output Circuits: Type XHHW-2 in metal conduit.
- J. Install dedicated neutral for every circuit.

**3.3 INSTALLATION OF CONDUCTORS AND CABLES**

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems" and Section 260548 "Vibration and Seismic Controls for Electrical Systems."

**3.4 CONNECTIONS**

- A. 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.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

**3.5 IDENTIFICATION**

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

**3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS**

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

**3.7 FIRESTOPPING**

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

**3.8 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
- B. Perform the following tests and inspections:
  - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance conductors, all switchboards, distribution boards, panelboards, and equipment feeder conductors for compliance with requirements.
  - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.
    - a. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
    - b. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Test and Inspection Reports: Prepare a written report to record the following:
  - 1. Procedures used.
  - 2. Results that comply with requirements.
  - 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Cables will be considered defective if they do not pass tests and inspections.

**END OF SECTION 26 05 19**  
07/10/2018

**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. UTP cabling.
  - 2. RS-485 cabling.
  - 3. Low-voltage control cabling.
  - 4. Control-circuit conductors.
  - 5. Identification products.

**1.3 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.
- C. Plenum: A space forming part of the air distribution system to which one or more air ducts are connected. An air duct is a passageway, other than a plenum, for transporting air to or from heating, ventilating, or air-conditioning equipment.
- D. RCDD: Registered Communications Distribution Designer.
- E. UTP: Unshielded twisted pair.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For testing agency, RCDD, layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

**1.6 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Accredited by NETA.
  - 1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.



**PART 2 - PRODUCTS**

**2.1 SYSTEM 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 application.

**2.2 PERFORMANCE REQUIREMENTS**

- A. Flame Travel and Smoke Density in Plenums: As determined by testing identical products according to NFPA 262, by a qualified testing agency. Identify products for installation in plenums with appropriate markings of applicable testing agency.
  - 1. Flame Travel Distance: 60 inches or less.
  - 2. Peak Optical Smoke Density: 0.5 or less.
  - 3. Average Optical Smoke Density: 0.15 or less.
- B. Flame Travel and Smoke Density for Riser Cables in Non-Plenum Building Spaces: As determined by testing identical products according to UL 1666.
- C. Flame Travel and Smoke Density for Cables in Non-Riser Applications and Non-Plenum Building Spaces: As determined by testing identical products according to UL 1685.

**2.3 UTP CABLE**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. 3M.
  - 2. ADC.
  - 3. Alpha Wire Company.
  - 4. AMP NETCONNECT; a TE Connectivity Ltd. company.
  - 5. Belden CDT Networking Division/NORDX.
  - 6. Berk-Tek Leviton; a Nexans/Leviton alliance.
  - 7. CommScope, Inc.
  - 8. Draka USA.
  - 9. General Cable; General Cable Corporation.
  - 10. Genesis Cable Products; Honeywell International, Inc.
  - 11. KRONE Incorporated.
  - 12. Mohawk; a division of Belden Networking, Inc.
  - 13. Nexans.
  - 14. Siemon.
  - 15. Siemon Co. (The).
  - 16. Superior Essex Inc.
  - 17. SYSTIMAX Solutions; a CommScope Inc. brand.
- B. Description: 100-ohm, four-pair UTP, 25-pair UTP covered with a thermoplastic jacket.
  - 1. Comply with ICEA S-90-661 for mechanical properties of Category 5e cables.
  - 2. Comply with ICEA S-102-700 for mechanical properties of Category 6 cables.
  - 3. Comply with TIA-568-C.1 for performance specifications.
  - 4. Comply with TIA-568-C.2, Category 5e.
  - 5. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with NEMA WC 66, UL 444 and NFPA 70 for the following types:
    - a. Communications, Plenum Rated: Type CMP complying with UL 1685.
    - b. Communications, Plenum Rated: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
    - c. Communications, Riser Rated: Type CMR complying with UL 1666 and ICEA S-103-701.

- d. Communications, Riser Rated: Type CMP, or Type CMR in listed plenum or riser communications raceway.
- e. Communications, Riser Rated: Type CMP or Type CMR in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- f. Communications, General Purpose: Type CM or Type CMG or Type CM, Type CMG, Type CMP, or Type CMR in listed communications raceways.
- g. Communications, General Purpose: Type CM, Type CMG, Type CMP, Type CMR, or Type CMX in metallic conduit installed per NFPA 70, Article 300.22, "Wiring in Ducts, Plenums, and Other Air-Handling Spaces."
- h. Communications, Limited Purpose: Type CMX or Type CM, Type CMG, Type CMP, or Type CMR.

## **2.4 UTP CABLE HARDWARE**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. ADC.
  - 2. American Technology Systems Industries, Inc.
  - 3. AMP NETCONNECT; a TE Connectivity Ltd. company.
  - 4. Belden CDT Networking Division/NORDX.
  - 5. Belden Inc.
  - 6. Corning Cable Systems.
  - 7. Dynacom Corporation.
  - 8. Hubbell Incorporated; Wiring Device-Kellems.
  - 9. Hubbell Premise Wiring.
  - 10. KRONE Incorporated.
  - 11. Leviton Manufacturing Co., Inc.
  - 12. Molex Premise Networks.
  - 13. Panduit Corp.
  - 14. Siemon Co. (The).
- B. General Requirements for Cable Connecting Hardware: Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
  - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
  - 1. Number of Jacks per Field: One for each four-pair UTP cable indicated.
- F. Jacks and Jack Assemblies: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA-568-C.1.
- G. Patch Cords: Factory-made, four-pair cables in 48-inch lengths; terminated with eight-position modular plug at each end.
  - 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
  - 2. Patch cords shall have color-coded boots for circuit identification.

- H. Workstation Outlets: Two-port-connector assemblies mounted in single faceplate.
- I. Faceplates:
  - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
  - 2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
  - 3. For use with snap-in jacks accommodating any combination of UTP, optical-fiber, and coaxial work area cords.
    - a. Flush-mounted jacks, positioning the cord at a 45-degree angle.
- J. Legend:
  - 1. Factory labeled by silk-screening or engraving for stainless steel faceplates.
  - 2. Machine printed, in the field, using adhesive-tape label.
  - 3. Snap-in, clear-label covers and machine-printed paper inserts.

## **2.5 LOW-VOLTAGE CONTROL CABLE**

- A. Paired Cable: NFPA 70, Type CMG.
  - 1. One-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with UL 1685.
- B. Plenum-Rated, Paired Cable: NFPA 70, Type CMP.
  - 1. One-pair, twisted, No. 16 AWG, stranded (19x29) tinned-copper conductors.
  - 2. PVC insulation.
  - 3. Unshielded.
  - 4. PVC jacket.
  - 5. Flame Resistance: Comply with NFPA 262.

## **2.6 CONTROL-CIRCUIT CONDUCTORS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Encore Wire Corporation.
  - 2. General Cable; General Cable Corporation.
  - 3. Service Wire Co.
  - 4. Southwire Company.
- B. Class 1 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway; Type XHHW-2, complying with UL 44 in raceway; Type MC, complying with UL 1569.
- C. Class 2 Control Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway; Type XHHW-2, complying with UL 44 in raceway; power-limited cable, concealed in building finishes.
- D. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type THHN/THWN-2, complying with UL 83 in raceway; Type XHHW-2, complying with UL 44 in raceway; power-limited cable, concealed in building finishes.
- E. Class 2 Control Circuits and Class 3 Remote-Control and Signal Circuits That Supply Critical Circuits: Circuit Integrity (CI) cable.
  - 1. Smoke control signaling and control circuits.

**2.7 SOURCE QUALITY CONTROL**

- A. Testing Agency: Engage a qualified testing agency to evaluate cables.
- B. Factory test UTP cables according to TIA-568-C.2.
- C. Factory test optical-fiber cables according to TIA-568-C.3.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Test cables on receipt at Project site.
  - 1. Test each pair of UTP cable for open and short circuits.

**3.2 INSTALLATION OF RACEWAYS AND BOXES**

- A. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for raceway selection and installation requirements for boxes, conduits, and wireways as supplemented or modified in this Section.
  - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.
  - 2. Outlet boxes for optical-fiber cables shall be no smaller than 4 inches square by 2-1/8 inches deep with extension ring sized to bring edge of ring to within 1/8 inch of the finished wall surface.
  - 3. Flexible metal conduit shall not be used.
- B. Comply with TIA-569-C for pull-box sizing and length of conduit and number of bends between pull points.
- C. Install manufactured conduit sweeps and long-radius elbows if possible.

**3.3 INSTALLATION OF CONDUCTORS AND CABLES**

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with TIA-568-C Series of standards.
  - 2. Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems."
  - 3. Terminate all conductors and optical fibers; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
  - 4. Cables may not be spliced.
  - 5. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Install lacing bars and distribution spools.
  - 7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Do not use heat lamps for heating.

9. Pulling Cable: Comply with BICSI ITSIMM, Ch. 5, "Copper Structured Cabling Systems" and Ch. 6, "Optical Fiber Structured Cabling Systems." Monitor cable pull tensions.
10. Support: Do not allow cables to lay on removable ceiling tiles.
11. Secure: Fasten securely in place with hardware specifically designed and installed so as to not damage cables.

C. UTP Cable Installation:

1. Comply with TIA-568-C.2.
2. Install termination hardware as specified in Section 271500 "Communications Horizontal Cabling" unless otherwise indicated.
3. Do not untwist UTP cables more than 1/2 inch at the point of termination to maintain cable geometry.

D. Installation of Control-Circuit Conductors:

1. Install wiring in raceways. Comply with requirements specified in Section 260533 "Raceways and Boxes for Electrical Systems."

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend copper cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 30 inches apart.
3. Cable shall not be run through or on structural members or in contact with pipes, ducts, or other potentially damaging items. Do not run cables between structural members and corrugated panels.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-C recommendations for separating unshielded copper voice and data communications cable from potential EMI sources including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 5 inches.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 12 inches.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 6 inches.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 12 inches.
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
  - a. Electrical Equipment or Circuit Rating Less Than 2 kVA: No requirement.
  - b. Electrical Equipment or Circuit Rating between 2 and 5 kVA: A minimum of 3 inches.
  - c. Electrical Equipment or Circuit Rating More Than 5 kVA: A minimum of 6 inches.
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

**3.4 REMOVAL OF CONDUCTORS AND CABLES**

- A. Remove abandoned conductors and cables. Abandoned conductors and cables are those installed that are not terminated at equipment and are not identified with a tag for future use.

**3.5 CONTROL-CIRCUIT CONDUCTORS**

- A. Minimum Conductor Sizes:
  - 1. Class 1 remote-control and signal circuits; No 14 AWG.
  - 2. Class 2 low-energy, remote-control, and signal circuits; No. 16 AWG.
  - 3. Class 3 low-energy, remote-control, alarm, and signal circuits; No 12 AWG.

**3.6 FIRESTOPPING**

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-C, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping" Chapter.

**3.7 GROUNDING**

- A. For data communication wiring, comply with TIA-607-B and with BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. For low-voltage control wiring and cabling, comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

**3.8 IDENTIFICATION**

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Identify data and communications system components, wiring, and cabling according to TIA-606-A; label printers shall use label stocks, laminating adhesives, and inks complying with UL 969.

**3.9 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- D. Perform tests and inspections with the assistance of a factory-authorized service representative.
- E. Tests and Inspections:
  - 1. Visually inspect UTP and optical-fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA-568-C.1.
  - 2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  - 3. Test UTP cabling for direct-current loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination, but not after cross-connection.

- a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in its "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in its "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
  
- F. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.
  
- G. End-to-end cabling will be considered defective if it does not pass tests and inspections.
  
- H. Prepare test and inspection reports.

**END OF SECTION 26 05 23**  
07/10/2018

**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 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.

**1.3 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For testing agency and testing agency's field supervisor.
- B. Field quality-control reports.

**1.4 QUALITY ASSURANCE**

- 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 application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Burndy; Part of Hubbell Electrical Systems.
  - 2. ERICO International Corporation.
  - 3. O-Z/Gedney; a brand of Emerson Industrial Automation.

**2.2 SYSTEM 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 application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

**2.3 CONDUCTORS**

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
  - 1. Solid Conductors: ASTM B 3.
  - 2. Stranded Conductors: ASTM B 8.
  - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
  - 4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
  - 5. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.



**2.4 CONNECTORS**

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

**PART 3 - EXECUTION**

**3.1 BUILDING GROUNDING**

- A. Project includes but is not limited to the following grounding components:
  - 1. Grounding of metal ductwork systems.
  - 2. Grounding of piping systems.
  - 3. Grounding of motorized equipment.
  - 4. Grounding of gas piping.
  - 5. Grounding of signal and communication equipment.

**3.2 APPLICATIONS**

- A. Conductors: Install solid conductor for No. 8 AWG and smaller, and stranded conductors for No. 6 AWG and larger unless otherwise indicated.
- B. Conductor Terminations and Connections:
  - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
  - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
  - 3. Connections to Structural Steel: Welded connectors.

**3.3 EQUIPMENT GROUNDING**

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.
- D. Signal and Communication Equipment: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS J-STD-607-A.

**3.4 INSTALLATION**

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

C. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

D. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

**3.5 LABELING**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.

**3.6 FIELD QUALITY CONTROL**

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells. Make tests at ground rods before any conductors are connected.
  - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
  - b. Perform tests by fall-of-potential method according to IEEE 81.

C. Grounding system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 ohms.

- F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

**END OF SECTION 26 05 26**  
07/10/2018

**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. This Section includes the following:
  - 1. Hangers and supports for electrical equipment and systems.
  - 2. Construction requirements for concrete bases.
- B. Related Sections include the following:
  - 1. Section 260548 "Vibration and Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

**1.3 DEFINITIONS**

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For the following:
  - 1. Steel slotted support systems.
- B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
  - 1. Trapeze hangers. Include Product Data for components.
  - 2. Steel slotted channel systems. Include Product Data for components.
  - 3. Equipment supports.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Welding certificates.

**1.7 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

**1.8 COORDINATION**

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.
- B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

**PART 2 - PRODUCTS**

**2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Allied Tube & Conduit.
    - b. Cooper B-Line, Inc.; a division of Cooper Industries.
    - c. ERICO International Corporation.
    - d. GS Metals Corp.
    - e. Thomas & Betts Corporation, A Member of the ABB Group.
    - f. Unistrut; an Atkore International company.
    - g. Wesanco, Inc.
  - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
  - 3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
  - 4. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
  - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      - 1) Hilti, Inc.

- 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
  - 3) MKT Fastening, LLC.
  - 4) Simpson Strong-Tie Co., Inc.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
    - 2) Empire Tool and Manufacturing Co., Inc.
    - 3) Hilti, Inc.
    - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
    - 5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
  4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
  5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
  6. Toggle Bolts: All-steel springhead type.
  7. Hanger Rods: Threaded steel.

## **2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES**

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

## **PART 3 - EXECUTION**

### **3.1 APPLICATION**

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
  1. Secure raceways and cables to these supports with two-bolt conduit clamps, single-bolt conduit clamps, or single-bolt conduit clamps using spring friction action for retention in support channel.

### **3.2 SUPPORT INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.

- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
1. To Wood: Fasten with lag screws or through bolts.
  2. To New Concrete: Bolt to concrete inserts.
  3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
  4. To Existing Concrete: Expansion anchor fasteners.
  5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
  6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts, beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69, or spring-tension clamps.
  7. To Light Steel: Sheet metal screws.
  8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

### **3.3 INSTALLATION OF FABRICATED METAL SUPPORTS**

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

### **3.4 PAINTING**

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.
- B. Touchup: Comply with requirements in Division 09 painting sections for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

**END OF SECTION 26 05 29**  
07/10/2018

**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. Metal conduits, tubing, and fittings.
  - 2. Nonmetal conduits, tubing, and fittings.
  - 3. Metal wireways and auxiliary gutters.
  - 4. Nonmetal wireways and auxiliary gutters.
  - 5. Surface raceways.
  - 6. Boxes, enclosures, and cabinets.

**1.3 DEFINITIONS**

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of conduit groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.
- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal 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.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
  - 4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.
- D. Source quality-control reports.



**1.6 COORDINATION**

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including luminaries, HVAC equipment, fire suppression system, and partition assemblies.

**PART 2 - PRODUCTS**

**2.1 METAL CONDUITS, TUBING, AND FITTINGS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Drawings or comparable product by one of the following:
  - 1. AFC Cable Systems; a part of Atkore International.
  - 2. Allied Tube & Conduit; a part of Atkore International.
  - 3. Anamet Electrical, Inc.
  - 4. Calconduit.
  - 5. Electri-Flex Company.
  - 6. FSR Inc.
  - 7. Korkap.
  - 8. Opti-Com Manufacturing Network, Inc (OMNI).
  - 9. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 10. Perma-Cote.
  - 11. Picoma Industries, Inc.
  - 12. Plasti-Bond.
  - 13. Republic Conduit.
  - 14. Southwire Company.
  - 15. Thomas & Betts Corporation; A Member of the ABB Group.
  - 16. Topaz Electric; a division of Topaz Lighting Corp.
  - 17. Western Tube and Conduit Corporation.
  - 18. Wheatland Tube Company.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. FMC: Comply with UL 1; zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:
    - a. Material: Steel.
    - b. Type: Setscrew or compression.
  - 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- I. Joint Compound for GRC or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

**2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Drawings or comparable product by one of the following:
  - 1. AFC Cable Systems; a part of Atkore International.
  - 2. Anamet Electrical, Inc.
  - 3. Arnco Corporation.
  - 4. CANTEX INC.
  - 5. CertainTeed Corporation.
  - 6. Condux International, Inc.
  - 7. Electri-Flex Company.
  - 8. Kraloy.
  - 9. Lamson & Sessions.
  - 10. Niedax Inc.
  - 11. RACO; Hubbell.
  - 12. Thomas & Betts Corporation; A Member of the ABB Group.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. ENT: Comply with NEMA TC 13 and UL 1653.
- D. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- F. Solvents and Adhesives: As recommended by conduit manufacturer.

**2.3 METAL WIREWAYS AND AUXILIARY GUTTERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Drawings or comparable product by one of the following:
  - 1. B-line, an Eaton business.
  - 2. Hoffman; a brand of Pentair Equipment Protection.
  - 3. MonoSystems, Inc.
  - 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1, Type 3R, Type 4 or Type 12 unless otherwise indicated, and sized according to NFPA 70.
  - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

**2.4 NONMETALLIC WIREWAYS AND AUXILIARY GUTTERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Drawings or comparable product by one of the following:
  - 1. Allied Moulded Products, Inc.
  - 2. Hoffman; a brand of Pentair Equipment Protection.

3. Lamson & Sessions.
  4. Niedax Inc.
- B. Listing and Labeling: Nonmetallic wireways and auxiliary gutters shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Description: PVC, extruded and fabricated to required size and shape, and having snap-on cover, mechanically coupled connections, and plastic fasteners.
- D. Fittings and Accessories: Couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings shall match and mate with wireways as required for complete system.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

## **2.5 SURFACE RACEWAYS**

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish in color selected by Architect.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Drawings or comparable product by one of the following:
    - a. Hubbell Incorporated; Wiring Device-Kellems.
    - b. MonoSystems, Inc.
    - c. Panduit Corp.
    - d. Wiremold / Legrand.

## **2.6 BOXES, ENCLOSURES, AND CABINETS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on the Drawings or comparable product by one of the following:
1. Adalet.
  2. Crouse-Hinds, an Eaton business.
  3. EGS/Appleton Electric.
  4. Erickson Electrical Equipment Company.
  5. FSR Inc.
  6. Hoffman; a brand of Pentair Equipment Protection.
  7. Hubbell Incorporated.
  8. Kraloy.
  9. Milbank Manufacturing Co.
  10. MonoSystems, Inc.
  11. Oldcastle Enclosure Solutions.
  12. O-Z/Gedney; a brand of Emerson Industrial Automation.
  13. Plasti-Bond.
  14. RACO; Hubbell.
  15. Spring City Electrical Manufacturing Company.
  16. Thomas & Betts Corporation; A Member of the ABB Group.
  17. Topaz Electric; a division of Topaz Lighting Corp.
  18. Wiremold / Legrand.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.
- E. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum or galvanized, cast iron with gasketed cover.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Gangable boxes are prohibited.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 or Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
  - 1. NEMA 250, Type 1, Type 3R or Type 12 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.

### **PART 3 - EXECUTION**

#### **3.1 RACEWAY APPLICATION**

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC.
  - 2. Concealed Conduit, Aboveground: GRC.
  - 3. Underground Conduit: RNC, Type EPC-80-PVC, direct buried.
  - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
  - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
  - 3. Exposed and Subject to Severe Physical Damage: GRC. Raceway locations include the following:
    - a. Mechanical rooms.
    - b. Raceways penetrating roof to within 3 ft. of enclosed switch.
  - 4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
  - 6. Damp or Wet Locations: GRC.

- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
  - 1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  - 2. EMT: Comply with NEMA FB 2.10.
    - a. Utilize steel compression fittings in the following locations:
      - 1) Damp locations.
      - 2) Boiler rooms.
      - 3) Mechanical rooms.
      - 4) Within block walls.
    - b. Utilize steel set-screw fittings in the following locations:
      - 1) Dry locations.
      - 2) Above suspended ceilings.
      - 3) Within stud walls.
  - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.
- F. Install surface raceways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

### 3.2 **INSTALLATION**

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
  - 1. Whenever any raceway crosses an expansion or seismic joint, provide a pull box on each side of the joint with sufficient length of flexible raceway to accommodate movement in all directions. See Section regarding seismic control for electrical work for additional requirements. Coordinate movement requirements at expansion and seismic joints with Structural Engineer of Record.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Conceal raceway and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- G. Support raceway within 12 inches of enclosures to which attached.

- H. Stub-ups to Above Recessed Ceilings:
  - 1. Use RMC for raceways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
  
- I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
  
- J. Join raceways with fittings designed and approved for the purpose and make joints tight.
  - 1. Use insulating bushings to protect conductors. Within return air plenums, utilize plenum-rated bushings.
  
- K. Protect conductors including conductors smaller than No. 4 AWG.
  
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
  
- M. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
  
- N. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
  
- O. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
  
- P. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Within return air plenums, utilize a No. 10 AWG conductor in place of a plastic line. Cap underground raceways designated as spare above grade alongside raceways in use.
  
- Q. Surface Raceways:
  - 1. Install surface raceway with a minimum 2-inch radius control at bend points.
  - 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
  
- R. Install raceway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings according to NFPA 70.
  
- S. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service raceway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.
  
- T. Comply with manufacturer's written instructions for solvent welding RNC and fittings.

U. Expansion-Joint Fittings:

1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F and that has straight-run length that exceeds 25 feet. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
  - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
  - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
  - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

V. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.
2. Use LFMC in damp or wet locations not subject to severe physical damage.
3. Healthcare facilities cable may be utilized in place of FMC as permitted in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

W. Mount boxes at heights indicated on Architectural Drawings.

X. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Y. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

Z. Locate boxes so that cover or plate will not span different building finishes.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

**3.3 FIRESTOPPING**

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

**3.4 PROTECTION**

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION 26 05 33**  
07/10/2018



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**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. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.
- B. Related Requirements:
  - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. LEED Submittals:
  - 1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
  - 2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

**PART 2 - PRODUCTS**

**2.1 SLEEVES**

- A. Wall Sleeves:
  - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
  - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:
  - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
  - b. For sleeve cross-section rectangle perimeter equal to, or more than 50 inches or more and one or more sides equal to, or more than 16 inches, thickness shall be 0.138 inch.

**2.2 SLEEVE-SEAL SYSTEMS**

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Advance Products & Systems, Inc.
  - b. CALPICO, Inc.
  - c. Metraflex Company (The).
  - d. Pipeline Seal and Insulator, Inc.
  - e. Proco Products, Inc.
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

**2.3 SLEEVE-SEAL FITTINGS**

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Flexicraft Industries.
  - b. HOLDRITE.
  - c. Link-Seal.

**2.4 GROUT**

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

**2.5 SILICONE SEALANTS**

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
  
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

**PART 3 - EXECUTION**

**3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS**

- A. Comply with NECA 1.
  
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
  
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
  1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  
  2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
  
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
  1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
  
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
  
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using [steel] [cast-iron] pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
  
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

**3.2 SLEEVE-SEAL-SYSTEM INSTALLATION**

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
  
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

**3.3 SLEEVE-SEAL-FITTING INSTALLATION**

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.
- E. Install seal fittings on conduits and cables, as required by NEC, which are in or pass through hazardous areas.
- F. Use sealing bushings on conduit and cable ends to effectively prevent the intrusion of water, a damp or corrosive atmosphere, hot or cold air, or dust.

**3.4 SLEEVE INSTALLATION FOR FIRE-RATED ELECTRICAL PENETRATIONS**

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078413 "Penetration Firestopping."
- B. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- C. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

**END OF SECTION 26 05 44**  
07/10/2018

**PART 1 - GENERAL**

**1.1 INTENT**

- A. It is the intent of this Specification to provide the basis of design for the vibration isolation, accommodation of differential seismic motion across building expansion/seismic joints, and seismic restraints on all systems specified under Divisions 26, 27 and 28. The term "SYSTEMS" applies to all equipment and raceways on the project. The following Specification provides a requirement for the attachment of all non-structural components to the structure.

**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.

**1.3 SUMMARY**

- A. This Section includes the following:
  - 1. Isolation pads.
  - 2. Spring isolators.
  - 3. Channel support systems.
  - 4. Anchorage bushings and washers.
  - 5. Building expansion/seismic joint accommodation equipment.
- B. Related Sections include the following:
  - 1. Section 260529 "Hangers and Supports for Electrical Systems" for commonly used electrical supports and installation requirements.

**1.4 DEFINITIONS**

- A. The IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.

**1.5 PERFORMANCE REQUIREMENTS**

- A. Comply with seismic restraint requirements in accordance with state and local codes and ordinances and the authority having jurisdiction.
- B. Determine the following, but not limited to, design criteria conditions for the project location required in accordance with all state and local codes and ordinances. Include criteria with code references in shop drawing submittal.
- C. Seismic-Restraint Loading:
  - 1. Site Class as Defined in the IBC: As determined by the Seismic Engineer.
  - 2. Assigned Building Classification Category as Defined in the IBC: III.
    - a. Component Importance Factor: 1.5 for life safety systems, components with hazardous content and components required for continued operation in Seismic Use Group III structures; 1.0 for all other components.
    - b. Component Response Modification Factor: As determined by the Seismic Engineer.
    - c. Component Amplification Factor: As determined by the Seismic Engineer.
  - 3. Design Spectral Response Acceleration at Short Periods (0.2 Second): 0.223.

4. Design Spectral Response Acceleration at 1.0-Second Period: 0.065.
  5. Seismic Design Category: A; Electrical systems are exempt from requirements for seismic bracing.  
B; Electrical systems are exempt from requirements for seismic bracing.
- D. Determine and design system accommodation of differential seismic motion across building expansion/seismic joints. Motion to be accommodated shall be determined by the Architect and the Structural Engineer of Record. Accommodation can be designed by either of the following suitable for project conditions and layout:
1. Design systems to have inherent flexibility required to accept the differential motion using pipe loops and/or offsets.
  2. Design system arrangement to localize area at which differential motion will occur by anchoring to each building and provide a set of expansion joints arranged to accept the motion and forces determined.

#### **1.6 ACTION SUBMITTALS**

- A. Product Data: For the following:
1. Include detailed type, style, materials, rated load, rated deflection, and overload capacity for each vibration isolation device.
- B. Delegated-Design Submittal: For vibration isolation details indicated to comply with performance requirements and design criteria, including analysis data.
1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, forces required to select vibration isolators and expansion/seismic joint accommodation.
    - a. Coordinate design calculations with wind-load calculations required for equipment mounted outdoors. Comply with requirements in other electrical Sections for equipment mounted outdoors.
  2. Indicate materials and dimensions and identify hardware, including attachment and anchorage devices.
  3. Field-fabricated supports.
  4. Building Expansion/Seismic Joint Accommodation Details: Detail fabrication and attachment of seismic restraints and expansion compensators. Show piping configuration including expansion compensators and piping lengths. Show anchorage details and indicate strength, quantity, diameter, and depth of penetration of anchors. Indicate direction and value of forces transmitted to piping and structure during seismic event and thermal expansion.

#### **1.7 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" article.
- D. Field quality-control test reports.

#### **1.8 QUALITY ASSURANCE**

- A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Comply with NFPA 70.

**1.9 COORDINATION**

- A. Coordinate size and location of concrete bases with vibration isolation requirements. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 03.
- B. Coordinate design of vibration isolation design with expansion compensation systems.
- C. Coordinate and design all attachments with building structural system.
- D. Coordinate and design all duct and pipe accommodations for building expansion/seismic joint crossovers.

**PART 2 - PRODUCTS**

**2.1 VIBRATION ISOLATORS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Kinetics Noise Control or a comparable product by one of the following:
  - 1. Mason Industries.
  - 2. Vibration Eliminator Co., Inc.
  - 3. Vibration Mountings & Controls, Inc.
- B. Elastomeric Pads: Arrange in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
  - 1. Resilient Material: Oil- and water-resistant neoprene. Standard neoprene for indoor applications or where pad is not exposed to elements. Bridge-bearing neoprene, complying with AASHTO M 251 for exterior applications or where pad is exposed to elements.
- C. Spring Isolators: Freestanding, laterally stable, open-spring isolators.
  - 1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch- thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
  - 6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.
- D. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
  - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch- thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
  - 2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.
  - 3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 7. Shall have OSHPD or approved anchorage ratings.



- E. Elastomeric Hangers: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods and vertical limit stop. Color-code or otherwise identify to indicate capacity range.
  
- F. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
  - 1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
  - 2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
  - 3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
  - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
  - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
  - 6. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
  - 7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
  - 8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

## **2.2 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION DEVICES**

- A. Flexible-Raceways and Loops: Refer to Section 260533 "Raceways and Boxes for Electrical Systems" for product requirements.
  - 1. Designed and installed in arrangement to accept motion and forces associated with seismic event and thermal expansion.

## **2.3 FACTORY FINISHES**

- A. Finish: Manufacturer's standard prime-coat finish ready for field painting.
  
- B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
  - 1. Powder coating on springs and housings.
  - 2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
  - 3. Baked enamel or powder coat for metal components on isolators for interior use.
  - 4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and equipment to receive vibration isolation control devices and building expansion/seismic joint accommodation for compliance with requirements for installation tolerances and other conditions affecting performance.
  
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
  
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 APPLICATIONS**

- A. Multiple Raceways or Cables: Secure raceways and cables to trapeze member with clamps approved for application by an evaluation service member of ICC-ES or an independent agency acceptable to authorities having jurisdiction.

**3.3 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION**

- A. Install flexible connections in runs of raceways, cables, wireways, cable trays, and busways where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where they terminate with connection to equipment that is anchored to a different structural element from the one supporting them as they approach equipment.

**3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
  - 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
  - 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
  - 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
  - 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
  - 5. Test to 90 percent of rated proof load of device.
  - 6. Measure isolator restraint clearance.
  - 7. Measure isolator deflection.
  - 8. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.
- C. Remove and replace malfunctioning units and retest as specified above.
- D. Prepare test and inspection reports.

**3.5 ADJUSTING**

- A. Adjust isolators after isolated equipment is at operating weight.
- B. Adjust limit stops on restrained spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.
- C. Adjust active height of spring isolators.
- D. Adjust restraints to permit free movement of equipment within normal mode of operation.

**END OF SECTION 26 05 48**  
07/10/2018

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**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. Identification for raceways.
  - 2. Identification of power and control cables.
  - 3. Identification for conductors.
  - 4. Warning labels and signs.
  - 5. Instruction signs.
  - 6. Equipment identification labels.
  - 7. Miscellaneous identification products.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each electrical identification product indicated.
- B. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.
- C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels. Furnish extra copies, in addition to mounted copies, for inclusion in maintenance manuals. Provide one copy on electronic media, type specified by Owner.

**1.4 QUALITY ASSURANCE**

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

**1.5 COORDINATION**

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications and with Owner's desired identification scheme, regardless of numbering indicated on the drawings and specifications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project. Coordinate Owner's desired identification scheme with NEMA and OSHA standards.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.

- D. Install identifying devices before installing acoustical ceilings and similar concealment.

## **PART 2 - PRODUCTS**

### **2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

### **2.2 ARMORED AND METAL-CLAD CABLE IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Colors for Cables Carrying Circuits at 600 V and Less:
  - 1. Black letters on an orange field.
  - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- D. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around cable it identifies. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.

### **2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

### **2.4 CONDUCTOR IDENTIFICATION MATERIALS**

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.
- C. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tube with machine-printed identification label. Sized to suit diameter of and shrinks to fit firmly around conductor it identifies. Full shrink recovery at a maximum of 200 deg F. Comply with UL 224.
- D. Write-On Tags: Polyester tag, 0.010 inch thick, with corrosion-resistant grommet and cable tie for attachment to conductor or cable.

1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

## **2.5 FLOOR MARKING TAPE**

- A. 2-inch- wide, 5-mil pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

## **2.6 WARNING LABELS AND SIGNS**

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Warning label and sign shall include, but are not limited to, the following legends:
  1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."
  2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES."

## **2.7 INSTRUCTION SIGNS**

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
  1. Engraved legend with black letters on white face.
  2. Punched or drilled for mechanical fasteners.
  3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

## **2.8 EQUIPMENT IDENTIFICATION LABELS**

- A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- B. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 2 inches.
- C. Equipment Label Content: Include equipment's drawing designation and Owner specified unique equipment number, drawing numbers where equipment is indicated (plans, details, and schedules), plus the specification section number and title where equipment is specified.

## **2.9 CABLE TIES**

- A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self extinguishing, one piece, self locking, Type 6/6 nylon.
  1. Minimum Width: 3/16 inch.
  2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
  3. Temperature Range: Minus 40 to plus 185 deg F.
  4. Color: Black.
- C. Plenum-Rated Cable Ties: Self extinguishing, UV stabilized, one piece, self locking.

1. Minimum Width: 3/16 inch.
2. Tensile Strength at 73 deg F, According to ASTM D 638: 7000 psi.
3. UL 94 Flame Rating: 94V-0.
4. Temperature Range: Minus 50 to plus 284 deg F.
5. Color: Black.

## **2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS**

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION**

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- H. Aluminum Wraparound Marker Labels and Metal Tags: Secure tight to surface of conductor or cable at a location with high visibility and accessibility.
- I. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
  1. Outdoors: UV-stabilized nylon.
  2. In Spaces Handling Environmental Air: Plenum rated.
- J. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

### **3.2 IDENTIFICATION SCHEDULE**

- A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Identify with self-adhesive vinyl label. Install labels at 10-foot maximum intervals.

- B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
  - 1. Power.
- C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.
  - 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
    - a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    - b. Colors for 208/110-V Circuits:
      - 1) Phase A: Black.
      - 2) Phase B: Red.
      - 3) Phase C: Blue.
    - c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- D. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- E. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use write-on tags, self-adhesive vinyl labels with the conductor or cable designation, origin, and destination.
- F. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive vinyl labels with the conductor designation.
- G. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- H. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
  - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
  - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
  - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- I. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
  - 1. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- J. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- K. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.



1. Comply with 29 CFR 1910.145.
  2. Identify system voltage with black letters on an orange background.
  3. Apply to exterior of door, cover, or other access.
  4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
    - a. Power transfer switches.
    - b. Controls with external control power connections.
  5. Color code all junction boxes and associated cover plates serving emergency equipment with red paint.
- L. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- M. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
    - a. Indoor Equipment: Self-adhesive, engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch-high label; where two lines of text are required, use labels 2 inches high.
    - b. Outdoor Equipment: Stenciled legend 4 inches high.
    - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
    - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
  2. Equipment to Be Labeled:
    - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be self-adhesive engraved, laminated acrylic or melamine label.
    - b. Enclosures and electrical cabinets.
    - c. Access doors and panels for concealed electrical items.
    - d. Enclosed switches.
    - e. Enclosed circuit breakers.
    - f. Enclosed controllers.
    - g. Variable-speed controllers.
    - h. Push-button stations.
    - i. Contactors.
    - j. Remote-controlled switches, dimmer modules, and control devices.
    - k. Monitoring and control equipment.

**END OF SECTION 26 05 53**  
07/10/2018

**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. Indoor occupancy and vacancy sensors.
  - 2. Switchbox-mounted occupancy sensors.
- B. Related Requirements:
  - 1. Section 262726 "Wiring Devices" for wall-box dimmers, non-networkable wall-switch occupancy sensors, and manual light switches.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings:
  - 1. Show installation details for the following:
    - a. Occupancy sensors.
    - b. Vacancy sensors.
    - c. Daylight sensors.
  - 2. Interconnection diagrams showing field-installed wiring.
  - 3. Include diagrams for power, signal, and control wiring.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plan(s) and elevations, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which equipment will be attached.
  - 3. Items penetrating finished ceiling, including the following:
    - a. Luminaires.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
    - f. Control modules.
    - g. Occupancy/Vacancy sensors.
    - h. Daylight sensors.
- B. Field quality-control reports.
- C. Sample Warranty: For manufacturer's warranties.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each type of lighting control device to include in operation and maintenance manuals.

## 1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace lighting control devices that fail(s) in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
    - a. Faulty operation of lighting control software.
    - b. Faulty operation of lighting control devices.
  2. Warranty Period: Five years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 INDOOR OCCUPANCY AND VACANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper Industries, Inc.
  2. Hubbell Building Automation, Inc.
  3. Leviton Manufacturing Co., Inc.
  4. Lithonia Lighting; Acuity Brands Lighting, Inc.
  5. Lutron Electronics Co., Inc.
  6. Philips Lighting Controls.
  7. Sensor Switch, Inc.
  8. Watt Stopper.
  9. Douglas Lighting Controls.
  10. Crestron.
- B. General Requirements for Sensors:
1. Wall or Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
  2. Dual technology.
  3. Separate power pack.
  4. Hardwired connection to switch.
  5. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  6. Operation:
    - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
    - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
    - c. Combination Sensor: Unless otherwise indicated, sensor shall be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes.
  7. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A.
  8. Power: Line voltage.

9. Power Pack: Dry contacts rated for 20-A LED load at 120-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Sensor has 24-V dc, 150-mA, Class 2 power source, as defined by NFPA 70.
  10. Mounting:
    - a. Sensor: Suitable for mounting in any position on a standard outlet box.
    - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure.
    - c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
  11. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
  12. Bypass Switch: Override the "on" function in case of sensor failure.
  13. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc; turn lights off when selected lighting level is present.
- C. PIR Type: Wall or ceiling mounted; detect occupants in coverage area by their heat and movement.
1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in..
  2. Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
  3. Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 feet when mounted on a 10-foot- high ceiling.
  4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.
- D. Ultrasonic Type: Wall or ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.
1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
  2. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 600 sq. ft. when mounted on a 96-inch- high ceiling.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
  4. Detection Coverage (Large Room): Detect occupancy anywhere within a circular area of 2000 sq. ft. when mounted on a 96-inch- high ceiling.
  5. Detection Coverage (Corridor): Detect occupancy anywhere within 90 feet when mounted on a 10-foot- high ceiling in a corridor not wider than 14 feet.
  6. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 84 inches above finished floor.
- E. Dual-Technology Type: Wall or ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is selectable in the field by operating controls on unit.
1. Sensitivity Adjustment: Separate for each sensing technology.
  2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches/s.
  3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. when mounted on a 96-inch- high ceiling.
  4. Detection Coverage (Room, Wall Mounted): Detect occupancy anywhere within a 180-degree pattern centered on the sensor over an area of 1000 square feet when mounted 48 inches above finished floor.

## 2.2 SWITCHBOX-MOUNTED OCCUPANCY SENSORS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
1. Cooper Industries, Inc.
  2. Hubbell Building Automation, Inc.
  3. Leviton Manufacturing Co., Inc.
  4. Lithonia Lighting; Acuity Brands Lighting, Inc.
  5. Lutron Electronics Co., Inc.
  6. Philips Lighting Controls.
  7. Sensor Switch, Inc.
  8. Watt Stopper.
  9. Crestron.
  10. Douglas Lighting Controls.
- B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor with manual on-off switch, suitable for mounting in a single gang switchbox, with provisions for connection to BAS.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application, and shall comply with California Title 24.
  2. Occupancy Sensor Operation: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn lights off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
  3. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F.
  4. Switch Rating: Not less than 800-VA LED load at 120 V, 1200-VA and 800-W incandescent.
  5. Include ground wire.
- C. Wall-Switch Sensor (Use for Appropriate Proper Coverage):
1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft.
  2. Sensing Technology: Dual technology - PIR and ultrasonic.
  3. Switch Type: SP, field-selectable automatic "on," or manual "on," automatic "off."
  4. Capable of controlling load in three-way application.
  5. Voltage: Match the circuit voltage.
  6. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 2 to 200 fc. The switch prevents the lights from turning on when the light level is higher than the set point of the sensor.
  7. Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
  8. Concealed, "off" time-delay selector at 30 seconds and 5, 10, and 20 minutes.
  9. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
  10. Color: As selected by Architect.
  11. Faceplate: Color matched to switch.

## 2.3 CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Install unshielded, twisted-pair cable for control and signal transmission conductors.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 SENSOR INSTALLATION**

- A. Comply with NECA 1.
- B. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment and devices, smoke detectors, fire-suppression systems, partition assemblies, and architectural features.
- C. Install and aim sensors in locations to achieve not less than 90-percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

**3.3 APPLICATION OF OCCUPANCY / VACANCY SENSORS**

- A. Install ultrasonic type devices within toilet rooms and storage rooms.
- B. Install dual technology type devices within classrooms, large offices over 140 sq. ft., open office spaces, and computer spaces.
- C. Install passive infrared type devices within all other areas.

**3.4 WIRING INSTALLATION**

- A. Comply with NECA 1.
- B. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
- C. Wiring within Enclosures: Comply with NECA 1. Bundle, lace and train conductors to terminal points. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.
- D. Size conductors according to lighting control device manufacturer's written instructions unless otherwise indicated.
- E. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

**3.5 IDENTIFICATION**

- A. Identify components and power and control wiring according to Section 260553 "Identification for Electrical Systems."
  - 1. Identify controlled circuits in lighting contactors.
  - 2. Identify circuits or luminaires controlled by photoelectric and occupancy sensors at each sensor.
- B. Label time switches and contactors with a unique designation.

**3.6 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Operational Test: After installing time switches 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.
- B. Lighting control devices will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

**3.7 ADJUSTING**

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.
  - 1. For occupancy and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.

**3.8 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. As a minimum and in addition to the requirements of other sections, provide two 4-hour days of owner training sessions in addition to multiple start-up visits to properly support the contractor.

**END OF SECTION 26 09 23**  
07/10/2018

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**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. Submittals will not be reviewed or accepted without a protective device coordination study report.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Lighting and appliance branch-circuit panelboards.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
  - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
  - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
  - 3. Detail bus configuration, current, and voltage ratings.
  - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
  - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
  - 6. Include wiring diagrams for power, signal, and control wiring.
  - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

**1.4 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified testing agency.
- B. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems." Include the following:
  - 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.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.



**1.5 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
  - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

**1.6 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Keys: Two spares for each type of panelboard cabinet lock.
  - 2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.
  - 3. Circuit Breakers: Equal to 5 percent of all 20A, 1-phase active circuit breakers over and above all spares listed in Panelboard Schedule.

**1.7 QUALITY ASSURANCE**

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. 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.
- D. Comply with NEMA PB 1.
- E. Comply with NFPA 70.

**1.8 DELIVERY, STORAGE, AND HANDLING**

- A. Handle and prepare panelboards for installation according to NEMA PB 1.

**1.9 PROJECT CONDITIONS**

- A. Environmental Limitations:
  - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
  - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
    - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
    - b. Altitude: Not exceeding 6600 feet.
- B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
  - 1. Ambient temperatures within limits specified.
  - 2. Altitude not exceeding 6600 feet.

- C. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Architect, Construction Manager and Owner no fewer than five days in advance of proposed interruption of electric service.
  2. Do not proceed with interruption of electric service without Architect's, Construction Manager's and Owner's written permission.
  3. Comply with NFPA 70E.

#### 1.10 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

#### 1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- B. Enclosures: Flush- and surface-mounted cabinets.
1. Rated for environmental conditions at installed location.
    - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
  2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
  3. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
  4. Finishes:
    - a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
    - b. Back Boxes: Galvanized steel.
  5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- C. Incoming Mains Location: Top or bottom as directed by contractor.
- D. Phase, Neutral, and Ground Buses:
1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
  3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
  4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.
- E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
  2. Main and Neutral Lugs: Mechanical type.
  3. Ground Lugs and Bus-Configured Terminators: Mechanical type.
  4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
  5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
  7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.
- F. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- G. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- H. Panelboard Short-Circuit Current Rating:
1. Fully rated to interrupt symmetrical short-circuit current available at terminals.
  2. Panelboards containing main breakers with instantaneous off function or main lugs only must be rated to withstand a short-circuit for a minimum of 30 cycles.

## **2.2 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

## **2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide General Electric Company; GE Consumer & Industrial - Electrical Distribution or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. Siemens Energy & Automation, Inc.
  3. Square D; a brand of Schneider Electric.
- B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.
- C. Mains: Refer to drawings.
- D. Branch Overcurrent Protective Devices: Plug-in or bolt-on circuit breakers, replaceable without disturbing adjacent units.
- E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

## 2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide General Electric Company; GE Consumer & Industrial - Electrical Distribution or comparable product by one of the following:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  2. Siemens Energy & Automation, Inc.
  3. Square D; a brand of Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits.
  2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
  3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
    - a. Instantaneous trip.
    - b. Long- and short-time pickup levels.
    - c. Long- and short-time time adjustments.
    - d. Ground-fault pickup level, time delay, and  $I^2 t$  response.
  4. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
  5. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
  6. Arc-Fault Circuit Interrupter (AFCI) Circuit Breakers: Comply with UL 1699; 120/240-V, single-pole configuration.
  7. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    - a. Standard frame sizes, trip ratings, and number of poles.
    - b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
    - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
    - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
    - e. Shunt Trip: 120-V trip coil energized from separate circuit, set to trip at 75 percent of rated voltage.
    - f. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
    - g. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
    - h. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

## 2.5 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

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## PART 3 - EXECUTION

### 3.1 CIRCUIT BREAKER APPLICATION

- A. Install the following types of circuit breakers within lighting and appliance and electronic-grade type panelboards as follows:
  - 1. Thermal-Magnetic: OCPDs under 400A.
  - 2. Electronic Trip Unit: OCPDs 400A and larger.
  - 3. Type SWD (Switching Duty): OCPDs serving lighting branch circuits without local switches.
  - 4. Type HACR (Heating, Air Conditioning and Refrigeration): OCPDs serving motor feeder and branch circuits requiring HACR devices.
  - 5. Type HID (High Intensity Discharge): OCPDs serving HID luminaire branch circuits.
  - 6. Type GF 5 mA (Ground-Fault): OCPDs serving receptacles, except as listed below, or where GF receptacles are utilized.
  - 7. Type GFEP 30 mA (Ground-Fault): OCPDs serving electric heating cable systems, sump pumps, and laboratory bench power branch circuits.
  - 8. Shunt-Trip: OCPDs serving electric devices under kitchen hood.
  - 9. GF breakers for all circuits serving devices within 6 ft. of sinks, except where GF receptacles are utilized.

### 3.2 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NEMA PB 1.1.
- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.3 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Mount panelboard so that centerline of top device is no higher than 79 inches above finished floor.
- D. Mount top of trim 90 inches above finished floor unless otherwise indicated.
- E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- F. Install overcurrent protective devices and controllers not already factory installed.
  - 1. Set field-adjustable, circuit-breaker trip ranges.
- G. Install filler plates in unused spaces.
- H. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

- J. Comply with NECA 1.

### 3.4 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable. Identify circuit breakers for future use as SPARE. Turn all spare circuit breakers to the OFF position.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

### 3.5 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Instruments and Equipment:
      - 1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Panelboards will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include thermograms or infrared photos for each panel, notation of deficiencies detected, remedial action taken, and observations after remedial action.

### 3.6 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

- B. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
1. Measure as directed during period of normal system loading.
  2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
  3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
  4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

**END OF SECTION 26 24 16**  
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**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. Straight-blade convenience.
  2. GFCI receptacles.
  3. Twist-locking receptacles.
  4. Toggle switches.
  5. Wall-box dimmers.
  6. Wall plates.
  7. Prefabricated multioutlet assemblies.

**1.3 DEFINITIONS**

- A. Abbreviations of Manufacturers' Names:
1. Cooper: Cooper Wiring Devices; Division of Cooper Industries, Inc.
  2. Hubbell: Hubbell Incorporated: Wiring Devices-Kellems.
  3. Leviton: Leviton Mfg. Company, Inc.
  4. Pass & Seymour: Pass& Seymour/Legrand.
- B. BAS: Building automation system.
- C. EMI: Electromagnetic interference.
- D. GFCI: Ground-fault circuit interrupter.
- E. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- F. RFI: Radio-frequency interference.
- G. UTP: Unshielded twisted pair.

**1.4 ADMINISTRATIVE REQUIREMENTS**

- A. Coordination:
1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
  2. Cord and Plug Sets: Match equipment requirements.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.
- C. Samples: One for each type of device and wall plate specified, in each color specified.



**1.6 INFORMATIONAL SUBMITTALS**

- A. Field quality-control reports.

**1.7 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing-label warnings and instruction manuals that include labeling conditions.

**PART 2 - PRODUCTS**

**2.1 GENERAL WIRING-DEVICE REQUIREMENTS**

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
  2. Devices shall comply with the requirements in this Section.
- D. Devices for Owner-Furnished Equipment:
1. Receptacles: Match plug and NEMA configurations.
  2. Cord and Plug Sets: Match equipment requirements.
- E. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

**2.2 STRAIGHT-BLADE RECEPTACLES**

- A. Duplex Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - a. Cooper - 5351 (single); CR5352 (duplex).
    - b. Hubbell - 5361 (single); 5362 (duplex).
    - c. Leviton - 5361 (single); 5362 (duplex).
    - d. Pass & Seymour - 5361 (single); 5362 (duplex).

**2.3 GF RECEPTACLES**

- A. General Description:
1. 125 V, 20 A, straight blade, self-testing feed-through type.
  2. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A, and FS W-C-596.
  3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GF Convenience Receptacles:

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Cooper - SGF20.
  - b. Hubbell - GFRST20.
  - c. Leviton - GFTR2.
  - d. Pass & Seymour - 2097.

**2.4 TWIST-LOCKING RECEPTACLES**

- A. Twist-Lock, Single Convenience Receptacles: 125 V, 20 A; comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.

**2.5 TOGGLE SWITCHES**

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

1. Single Pole:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - 1) Cooper - AH1221.
    - 2) Hubbell - 1221.
    - 3) Leviton - 1221-S.
    - 4) Pass & Seymour - CS20AC.
2. Two Pole:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - 1) Cooper - AH1222.
    - 2) Hubbell - 1222.
    - 3) Leviton - 1222-S.
    - 4) Pass & Seymour - CS20AC.
3. Three Way:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - 1) Cooper - AH1223.
    - 2) Hubbell - 1223.
    - 3) Leviton - 1223-S.
    - 4) Pass & Seymour - CSB20AC.
4. Four Way:
  - a. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
    - 1) Cooper.
    - 2) Hubbell - 1224.
    - 3) Leviton - 1224-S.

4) Pass & Seymour - CSB20AC.

C. Pilot-Light Switches: 120/277 V, 20 A.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Cooper - 1221PL for 120-V and 277-V.
  - b. Hubbell - HBL1201PL for 120-V and 277-V.
  - c. Leviton - 1221-LH1.
  - d. Pass & Seymour - PS20AC1RPL for 120-V, PS20AC1RPL7 for 277-V.
2. Description: Single pole, with LED-lighted handle, illuminated when switch is off.

D. Key-Operated Switches: 120/277 V, 20 A.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Cooper - AH1221L.
  - b. Hubbell - HBL1221L.
  - c. Leviton - 1221-2L.
  - d. Pass & Seymour - PS20AC1-L.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc. - 1995.
  - b. Hubbell Incorporated; Wiring Device-Kellems - HBL1557.
  - c. Leviton Manufacturing Co., Inc. - 1257.
  - d. Pass & Seymour/Legrand (Pass & Seymour) - 1251.

F. Key-Operated, Single-Pole, Double-Throw, Momentary-Contact, Center-off Switches: 120/277 V, 20 A; for use with mechanically held lighting contactors, with factory-supplied key in lieu of switch handle.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Cooper Wiring Devices, Inc.; Division of Cooper Industries, Inc. - 1995L.
  - b. Hubbell Incorporated; Wiring Device-Kellems - HBL1557L.
  - c. Leviton Manufacturing Co., Inc. - 1257L.
  - d. Pass & Seymour/Legrand (Pass & Seymour) - 1251L.

**2.6 WALL-BOX DIMMERS**

- A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
- B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.
  1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "off."
- C. LED Lamp Dimmer Switches: Modular; compatible with LED lamps; trim potentiometer to adjust low-end dimming; capable of consistent dimming with low end not greater than 20 percent of full brightness.

## 2.7 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
  - 1. Plate-Securing Screws: Metal with head color to match plate finish.
  - 2. Material for Finished Spaces: Smooth, high-impact thermoplastic 0.035-inch- thick, satin-finished, Type 302 stainless steel.
  - 3. Material for Unfinished Spaces: Smooth, high-impact thermoplastic.
  - 4. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant thermoplastic with lockable cover.

## 2.8 PREFABRICATED MULTIOUTLET ASSEMBLIES

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - 1. Hubbell Incorporated; Wiring Device-Kellems.
  - 2. Wiremold / Legrand.
  - 3. Mono-Systems.
- B. Description:
  - 1. Two-piece surface metal raceway, with factory-wired multioutlet harness.
  - 2. Components shall be products from single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.
- C. Raceway Material: Steel color as selected by Architect.
- D. Multioutlet Harness:
  - 1. Receptacles: 15-A, 125-V, NEMA WD 6 Configuration 5-15R receptacles complying with NEMA WD 1, UL 498, and FS W-C-596.
  - 2. Receptacle Spacing: As shown on plans.
  - 3. Wiring: No. 12 AWG solid, Type THHN copper, two circuit, connecting alternating receptacles.

## 2.9 FINISHES

- A. Device Color:
  - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
- B. Wall Plate Color: For plastic covers, match device color.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
  - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
  - a. Cut back and pigtail, or replace all damaged conductors.
  - b. Straighten conductors that remain and remove corrosion and foreign matter.
  - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
8. Tighten unused terminal screws on the device.
9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the left.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

G. Dimmers:

1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan-speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

### 3.2 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."

- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

**3.3 FIELD QUALITY CONTROL**

- A. Test Instruments: Use instruments that comply with UL 1436.
- B. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
  - 1. Test Instruments: Use instruments that comply with UL 1436.
  - 2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.
- D. Tests for Convenience Receptacles:
  - 1. Line Voltage: Acceptable range is 105 to 132 V.
  - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
  - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
  - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
  - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
  - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- E. Wiring device will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.

**END OF SECTION 26 27 26**  
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**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. Cartridge fuses rated 600-V ac and less for use in control circuits, enclosed switches and enclosed controllers.
  2. Spare-fuse cabinets.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.
    - a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.
    - b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.
  2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.
  3. Current-limitation curves for fuses with current-limiting characteristics.
  4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  5. Coordination charts and tables and related data.
  6. Fuse sizes for elevator feeders and elevator disconnect switches.

**1.4 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Ambient temperature adjustment information.
  2. Current-limitation curves for fuses with current-limiting characteristics.
  3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.
  4. Coordination charts and tables and related data.

**1.5 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fuses: Equal to 20 percent of quantity installed for each size and type, but no fewer than six of each size and type.



**1.6 QUALITY ASSURANCE**

- A. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single 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 application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.

**1.7 PROJECT CONDITIONS**

- A. Where ambient temperature to which fuses are directly exposed is less than 40 deg F or more than 100 deg F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

**1.8 COORDINATION**

- A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

**PART 2 - PRODUCTS****2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Cooper Bussmann, Inc. or comparable product by one of the following:
  - 1. Edison Fuse, Inc.
  - 2. Ferraz Shawmut, Inc.
  - 3. Littelfuse, Inc.

**2.2 CARTRIDGE FUSES**

- A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

**2.3 SPARE-FUSE CABINET**

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.
  - 1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.
  - 2. Finish: Gray, baked enamel.
  - 3. Identification: "SPARE FUSES" in 1-1/2-inch- high letters on exterior of door.
  - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

**PART 3 - EXECUTION****3.1 EXAMINATION**

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

- C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.
- D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
  - 1. Feeders: Class RK5, time delay.
  - 2. Motor Branch Circuits: Class RK1, time delay.
  - 3. Other Branch Circuits: Class RK5, time delay.
  - 4. Control Circuits: Class CC, time delay.

### 3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet in existing boiler room.

### 3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

**END OF SECTION 26 28 13**

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**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Fusible switches.
  - 2. Nonfusible switches.
  - 3. Molded-case circuit breakers (MCCBs).
  - 4. Enclosures.

**1.3 DEFINITIONS**

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
  - 1. Enclosure types and details for types other than NEMA 250, Type 1.
  - 2. Current and voltage ratings.
  - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
  - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
  - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.
- B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Wiring Diagrams: For power, signal, and control wiring.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

**1.7 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
  2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

**1.8 QUALITY ASSURANCE**

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- C. 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.
- D. Comply with NFPA 70.

**1.9 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of electric service.
  2. Indicate method of providing temporary electric service.
  3. Do not proceed with interruption of electric service without Owner's written permission.
  4. Comply with NFPA 70E.

**1.10 COORDINATION**

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

**PART 2 - PRODUCTS**

**2.1 FUSIBLE SWITCHES**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton Electrical Inc.; Cutler-Hammer Business Unit or comparable product by one of the following:
  - 1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square D; a brand of Schneider Electric.
  
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
  
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
  - 4. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.
  - 6. Service-Rated Switches: Labeled for use as service equipment.
  - 7. Accessory Control Power Voltage: Integrally mounted and self-powered; 20-V ac or 24-V dc. Coordinate in field.

**2.2 NONFUSIBLE SWITCHES**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton Electrical Inc.; Cutler-Hammer Business Unit or comparable product by one of the following:
  - 1. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square D; a brand of Schneider Electric.
  
- B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
  
- C. Accessories:
  - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
  - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 3. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
  - 4. Hookstick Handle: Allows use of a hookstick to operate the handle.
  - 5. Lugs: Mechanical type, suitable for number, size, and conductor material.
  - 6. Accessory Control Power Voltage: Integrally mounted and self-powered; 120-V ac or 24-V dc. Coordinate in field.

### 2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide General Electric Company; GE Consumer & Industrial - Electrical Distribution or comparable product by one of the following:
  - 1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
  - 2. Siemens Energy & Automation, Inc.
  - 3. Square D; a brand of Schneider Electric.
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
  - 1. Instantaneous trip.
  - 2. Long- and short-time pickup levels.
  - 3. Long- and short-time time adjustments.
  - 4. Ground-fault pickup level, time delay, and  $I^2t$  response.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
- G. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).
- H. Features and Accessories:
  - 1. Standard frame sizes, trip ratings, and number of poles.
  - 2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
  - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding high-intensity discharge lighting circuits.
  - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
  - 5. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.
  - 6. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
  - 7. Alarm Switch: One NO or NC contact that operates only when circuit breaker has tripped.
  - 8. Accessory Control Power Voltage: Integrally mounted, self-powered; 120-V ac or 24-V dc. Coordinate in field.

### 2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
  - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
  - 2. Outdoor Locations: NEMA 250, Type 3R.
  - 3. Wet or Damp, Indoor Locations: NEMA 250, Type 4.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with 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. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Comply with mounting and anchoring requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in fusible devices.
- E. Comply with NECA 1.

**3.3 IDENTIFICATION**

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

**3.4 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
  - 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
  - 2. Test continuity of each circuit.
- C. Tests and Inspections:
  - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  - 3. Perform the following infrared scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  - 4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.



- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

**3.5 ADJUSTING**

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

**END OF SECTION 26 28 16**  
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**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 the following enclosed controllers rated 600 V and less:
  - 1. Full-voltage manual.
  - 2. Full-voltage magnetic.

**1.3 DEFINITIONS**

- A. CPT: Control power transformer.
- B. MCCB: Molded-case circuit breaker.
- C. MCP: Motor circuit protector.
- D. N.C.: Normally closed.
- E. N.O.: Normally open.
- F. OCPD: Overcurrent protective device.
- G. SCR: Silicon-controlled rectifier.

**1.4 PERFORMANCE REQUIREMENTS**

- A. Seismic Performance: Enclosed controllers shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
  - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.
- B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.
  - 1. Show tabulations of the following:
    - a. Each installed unit's type and details.
    - b. Factory-installed devices.
    - c. Nameplate legends.
    - d. Short-circuit current rating of integrated unit.
  - 2. Wiring Diagrams: For power, signal, and control wiring.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Seismic Qualification Certificates: For enclosed controllers, 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.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.
- C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.
- D. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed, and arrange to demonstrate that switch settings for motor running overload protection suit actual motors to be protected.

**1.7 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
  - 1. Routine maintenance requirements for enclosed controllers and installed components.
  - 2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.
  - 3. Manufacturer's written instructions for setting field-adjustable overload relays.
  - 4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

**1.8 MATERIALS MAINTENANCE SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
  - 2. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.
  - 3. Indicating Lights: Two of each type and color installed.
  - 4. Auxiliary Contacts: Furnish one spare(s) for each size and type of magnetic controller installed.
  - 5. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

**1.9 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.
- 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 application.
- C. Comply with NFPA 70.
- D. IEEE Compliance: Fabricate and test enclosed controllers according to IEEE 344 to withstand seismic forces defined in Section 260548 "Vibration and Seismic Controls for Electrical Systems."

**1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install temporary electric heating, with at least 250 W per controller.

**1.11 PROJECT CONDITIONS**

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
  - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
  - 2. Altitude: Not exceeding 6600 feet.
- B. Interruption of Existing Electrical Systems: Do not interrupt electrical systems in facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
  - 1. Notify Architect, Construction Manager and Owner no fewer than [two] days in advance of proposed interruption of electrical systems.
  - 2. Indicate method of providing temporary utilities.
  - 3. Do not proceed with interruption of electrical systems without Architect's, Construction Manager's and Owner's written permission.
  - 4. Comply with NFPA 70E.

**1.12 COORDINATION**

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

**PART 2 - PRODUCTS**

**2.1 FULL-VOLTAGE CONTROLLERS**

- A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.
- B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.
  - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton Electrical Inc.; Cutler-Hammer Business Unit or comparable product by one of the following:
    - a. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. Square D; a brand of Schneider Electric.
  - 2. Configuration: Nonreversing.
  - 3. Surface mounting.

4. Red pilot light.
- C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton Electrical Inc.; Cutler-Hammer Business Unit or comparable product by one of the following:
    - a. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. Square D; a brand of Schneider Electric.
  2. Configuration: Nonreversing.
  3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button; bimetallic type.
  4. Surface mounting.
  5. Red pilot light.
- D. Magnetic Controllers: Full voltage, across the line, electrically held.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton Electrical Inc.; Cutler-Hammer Business Unit or comparable product by one of the following:
    - a. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.
    - c. Siemens Energy & Automation, Inc.
    - d. Square D; a brand of Schneider Electric.
  2. Configuration: Nonreversing.
  3. Contactor Coils: Pressure-encapsulated type.
    - a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
  4. Power Contacts: Totally enclosed, double-break, silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.
  5. Control Circuits: 24-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
    - a. CPT Spare Capacity: 100 VA.
  6. Solid-State Overload Relay:
    - a. Switch or dial selectable for motor running overload protection.
    - b. Sensors in each phase.
    - c. Class 10/20 selectable tripping characteristic selected to protect motor against voltage and current unbalance and single phasing.
- E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.
1. Basis-of-Design Product: Subject to compliance with requirements, provide Eaton Electrical Inc.; Cutler-Hammer Business Unit or comparable product by one of the following:
    - a. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
    - b. Rockwell Automation, Inc.; Allen-Bradley brand.

- c. Siemens Energy & Automation, Inc.
  - d. Square D; a brand of Schneider Electric.
2. Fusible Disconnecting Means:
- a. NEMA KS 1, heavy-duty, horsepower-rated, fusible switch with clips or bolt pads to accommodate Class R fuses.
  - b. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

## **2.2 ENCLOSURES**

- A. Enclosed Controllers: NEMA ICS 6, to comply with environmental conditions at installed location.
- 1. Dry and Clean Indoor Locations: Type 1.
  - 2. Outdoor Locations: Type 3R.
  - 3. Wet or Damp Indoor Locations: Type 4.

## **2.3 ACCESSORIES**

- A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.
- 1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.
    - a. Push Buttons: Covered Recessed types; momentary as indicated.
    - b. Pilot Lights: LED types; colors as indicated; push to test.
    - c. Selector Switches: Rotary type.
  - 2. Elapsed Time Meters: Heavy duty with digital readout in hours; resettable.
- B. Two sets of reversible N.C./N.O. auxiliary contact(s).
- C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.
- D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.
- E. Sun shields installed on fronts, sides, and tops of enclosures installed outdoors and subject to direct and extended sun exposure.
- F. Cover gaskets for Type 1 enclosures.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
- B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.2 APPLICATIONS**

- A. The contractor who furnishes equipment requiring a motor controller shall provide motor controllers for all motors with all specified options and accessories.
- B. Select features of each enclosed control to coordinate with ratings and characteristics of supply circuit and motor.
- C. Select horsepower rating of controllers to suit motor controlled.
- D. Provide each enclosed controller with an H.O.A. switch, pilot lights, pushbuttons, elapsed time meter, integral transformer and fusing.
- E. Location: Locate enclosed controller within sight of motor controller in readily accessible location, unless otherwise required. When controller is not located within sight of the motor, provide an additional maintenance enclosed switch at the motor.

### **3.3 INSTALLATION**

- A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."
- B. Seismic Bracing: Comply with requirements specified in Section 260548 "Vibration and Seismic Controls for Electrical Systems."
- C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- D. Install fuses in each fusible-switch enclosed controller.
- E. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."
- F. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.
- G. Comply with NECA 1.

### **3.4 IDENTIFICATION**

- A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
  - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
  - 2. Label each enclosure with engraved nameplate.
  - 3. Label each enclosure-mounted control and pilot device.

### **3.5 CONTROL WIRING INSTALLATION**

- A. Install wiring between enclosed controllers and remote devices and facility's central control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.
2. Connect selector switches with enclosed-controller circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

### **3.6 FIELD QUALITY CONTROL**

- A. Perform tests and inspections.
  1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- B. Acceptance Testing Preparation:
  1. Test insulation resistance for each enclosed controller, component, connecting supply, feeder, and control circuit.
  2. Test continuity of each circuit.
- C. Tests and Inspections:
  1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
  2. Test insulation resistance for each enclosed-controller element, component, connecting motor supply, feeder, and control circuits.
  3. Test continuity of each circuit.
  4. Verify that voltages at controller locations are within plus or minus 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect, Construction Manager and Owner before starting the motor(s).
  5. Test each motor for proper phase rotation.
  6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
  7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
  8. Perform the following infrared (thermographic) scan tests and inspections and prepare reports:
    - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each multi-pole enclosed controller. Remove front panels so joints and connections are accessible to portable scanner.
    - b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each multi-pole enclosed controller 11 months after date of Substantial Completion.
    - c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
  9. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Enclosed controllers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports including a certified report that identifies enclosed controllers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

### **3.7 ADJUSTING**

- A. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.



- B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.
- C. Set field-adjustable switches and program microprocessors for required start and stop sequences in reduced-voltage solid-state controllers.

**3.8 PROTECTION**

- A. Replace controllers whose interiors have been exposed to water or other liquids prior to Substantial Completion.

**3.9 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.

**END OF SECTION 26 29 13**  
07/10/2018

**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. Interior luminaires, lamps, drivers, and ballasts.
  - 2. Emergency lighting units.
  - 3. Exit signs.
  - 4. Luminaire supports.
- B. Related Sections:
  - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

**1.3 DEFINITIONS**

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LED: Light emitting diode (lamp assembly).
- F. LER: Luminaire efficacy rating.
- G. Lumen: Measured output of lamp and luminaire, or both.
- H. Luminaire: Complete lighting fixture, including ballast housing if provided.
- I. SSL: Solid-state lighting.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of luminaire, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
  - 1. Physical description of luminaire including dimensions.
  - 2. Emergency lighting units including battery and charger.
  - 3. Ballast, including BF.
  - 4. Energy-efficiency data.
  - 5. Air and Thermal Performance Data: For air-handling luminaires. Furnish data required in "Action Submittals" Article in Section 233713 "Diffusers, Registers, and Grilles."
  - 6. Sound Performance Data: For air-handling luminaires. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 233713 "Diffusers, Registers, and Grilles."
  - 7. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

8. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the luminaire as applied in this Project.
  - a. Photometric data for all LED products shall be certified by an IESNA LM-79 test report.
  - b. Life expectancy data for all LED products shall be certified by an IESNA LM-80 test report.
9. Plans: Plans containing computer-generated point-by-point layout in all spaces that interior luminaires submitted or substitutions are located.
  - a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
- B. Shop Drawings: For nonstandard or custom luminaires. Include plans, elevations, sections, details, and attachments to other work.
  1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  2. Wiring Diagrams: For power, signal, and control wiring.

#### **1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Reflected ceiling plan(s) and other 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. Luminaires.
  2. Suspended ceiling components.
  3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches of the plane of the luminaires.
  4. Ceiling-mounted projectors.
  5. Structural members to which suspension systems for luminaires will be attached.
  6. Other items in finished ceiling including the following:
    - a. Air outlets and inlets.
    - b. Speakers.
    - c. Sprinklers.
    - d. Smoke and fire detectors.
    - e. Occupancy sensors.
    - f. Access panels.
  7. Perimeter moldings.
- B. Qualification Data: For qualified agencies providing photometric data for luminaires.
- C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.

#### **1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.
  1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

**1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
  - 2. LED-fixture-mounted, emergency battery pack: One for every 50 emergency lighting unit. Furnish at least one of each type.
  - 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
  - 4. LED Boards: One for every 20 of each type. Furnish at least one board for each luminaire type.
  - 5. LED Drivers: One for every 20 of each type. Furnish at least one driver for each luminaire type.

**1.8 ADDITIONAL SCOPE TO BE INCLUDED IN BASE CONTRACT**

- A. Provide the following luminaires connected to the nearest similar type light fixture in addition to those indicated on the drawings:
  - 1. Exit Luminaire: One for every 20 installed. Furnish at least one.

**1.9 QUALITY ASSURANCE**

- A. Luminaire Photometric Data Testing Laboratory Qualifications: 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.
- 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 application.
- C. Comply with NFPA 70.
- D. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.
- E. International Fire Code Compliance: Comply with visibility and luminance requirements for exit signs.
- F. Mockups: Provide interior luminaires for room or module mockups, complete with power and control connections.
  - 1. Obtain Architect's approval of fixtures for mockups before starting installations.
  - 2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
  - 3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

**1.10 COORDINATION**

- A. Coordinate layout and installation of luminaires and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies. Coordinate type of luminaire with ceiling type and insulation. Notify Engineer of conflicts prior to ordering fixtures via coordination drawings described in this Section.

**1.11 WARRANTY**

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: Three full years from date of Substantial Completion. a prorated warranty is not acceptable.
2. Warranty Period for Emergency LED Driver and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. A prorated warranty is not acceptable.

## **PART 2 - PRODUCTS**

### **2.1 MANUFACTURERS**

- A. Products: Subject to compliance with requirements below.
  1. Luminaires:
    - a. If only one manufacturer is listed in Luminaire Schedule, contractor must submit on this product.
    - b. If multiple manufacturers are listed in the Luminaire Schedule, the first named manufacturer listed in the luminaire schedule is the basis of design, if the electrical contractor chooses to provide one of the listed acceptable equivalent manufacturers, the light fixture submittal in addition to proposed light fixtures shall include lighting calculations for interior areas to demonstrate equivalent fixture performance. Light fixture samples shall be provided at the request of the Architect and/or Engineer.
    - c. If one manufacturer is listed in Luminaire Schedule followed by the words "or equal," contractor may submit on any manufacturer with similar characteristics to those listed under description.
    - d. Contactor may offer substitutions to manufacturers listed in Luminaire Schedule, but must follow procedures stated in "Product Requirements" under "Submittals" within Division 01.

### **2.2 GENERAL REQUIREMENTS FOR LUMINAIRES AND COMPONENTS**

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. LED Luminaires: Comply with UL 1598. Test according to IESNA LM-79 and LM-80 as applicable.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- E. 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.
- F. Diffusers and Globes:
  1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
    - a. Lens Thickness: At least 0.125 inch minimum thickness unless otherwise indicated. D12 pattern.
    - b. UV stabilized.
  2. Glass: Annealed crystal glass unless otherwise indicated.
- G. Factory-Applied Labels: Comply with UL 1598. Include recommended boards and drivers. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles.

- H. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate luminaires with one filter on each ballast indicated to require a filter.
- I. Mounting Provisions for Ceiling Trim: Mounting provisions and ceiling trim are not indicated on the specific luminaire type specification. Coordinate mounting provisions and ceiling trim in the field, prior to the ordering of luminaires to match all ceiling types and installation configurations. Provide all necessary mounting hardware, hangers, rails, yokes, steams, chains, cables, etc.

### **2.3 DRIVERS FOR LED LAMPS**

- A. Description: Electronic driver designed for applicable fixture(s) and load indicated by LED lamps. Driver shall be designed for full light output unless dimmer or bi-level control is indicated.
  - 1. Input Voltage Range: 120-277, +/-10%.
  - 2. Output Current: 0.35A dc.
  - 3. Input Frequency: 50/60 Hz.
  - 4. Power Factor: >90% at full load.
  - 5. THD: <20% at full load.
  - 6. Case temperature rated for -40 deg C through +80 deg C.
  - 7. Overheat protection, self-limited short-circuit protection and overload protected.
  - 8. Primary fused.
  - 9. 0-10V dimming.

### **2.4 EXIT SIGNS**

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction. Comply with International Fire Code for size of Chevron-type circuits and indicator, which must be identifiable as a directional indicator at a distance of 40ft.
- B. Internally Lighted Signs:
  - 1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
  - 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
    - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
    - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
    - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
    - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
    - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
    - f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
    - g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
  - 3. Master/Remote Sign Configurations:
    - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply, battery for power connection to remote unit.
    - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

- C. Self-Luminous Signs: Powered by tritium gas, with universal bracket for flush-ceiling, wall, or end mounting. Signs shall be guaranteed by manufacturer to maintain the minimum brightness requirements in UL 924 for 10 years.
- D. Self-Luminous Signs: Using strontium oxide aluminate compound to store ambient light and release the stored energy when the light is removed. Provide with universal bracket for flush-ceiling, wall, or end mounting.

## **2.5 EMERGENCY LUMINAIRES**

- A. General Requirements for Emergency Luminaires: Self-contained units complying with UL 924.
  - 1. Battery: Sealed, maintenance-free, lead-acid type.
  - 2. Charger: Fully automatic, solid-state type with sealed transfer relay.
  - 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
  - 4. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
  - 5. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
  - 6. Wire Guard: Heavy-chrome-plated wire guard protects lamp heads or fixtures.
  - 7. Integral Time-Delay Relay: Holds unit on for fixed interval of 15 minutes when power is restored after an outage.
  - 8. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
  - 9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

## **2.6 LED LAMPS**

- A. Manufacturers: Subject to compliance with requirements, provide one of the following products:
  - 1. Cree.
  - 2. Nichia.
  - 3. Lumileds.
- B. Provide tight binning to maintain Kelvin temperature between +/-100 K. Indoor lighting to be 3500 K unless noted otherwise.

## **2.7 LED LUMINAIRES**

- A. Provide luminaires complete with drivers compatible with control type.
- B. Provide LM 79 and LM 80 reports with luminaire submittal.
- C. Provide full IES photometric files with fixture submittal and run photometric calculations if fixture is other than base spec.

## **2.8 LUMINAIRE SUPPORT COMPONENTS**

- A. Comply with 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 swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

### **PART 3 - EXECUTION**

#### **3.1 INSTALLATION**

- A. Luminaires:
  - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
  - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.
- C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Luminaires Supports: Use grid as a support element.
  - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from luminaire corners.
  - 2. Support Clips: Fasten to luminaires and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
  - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
  - 4. Install at least two independent support rods or wires from structure to a tab on diagonal corners of luminaire. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Suspended Luminaire Support:
  - 1. Pendants and Rods: Where longer than 48 inches, brace to limit swinging.
  - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
  - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
  - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
  - 5. Pendant Stem-Mounted Fixtures: Connect luminaire body to building structure with aircraft cable run through the fixture stem.
- F. Air-Handling Luminaires: Install with dampers closed and ready for adjustment.



- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- H. Luminaire Locations: Refer to architectural reflected ceiling plans, sections, elevations and details for exact luminaire locations, mounting heights, and mounting arrangements.

**3.2 IDENTIFICATION**

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

**3.3 FIELD QUALITY CONTROL**

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.
- C. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

**3.4 STARTUP SERVICE**

- A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner.

**3.5 ADJUSTING**

- A. Luminaire Aiming: For adjustable luminaires, aim all luminaires per Engineer's directions.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
  - 1. Adjust aimable luminaires in the presence of Architect.

**END OF SECTION 26 51 00**  
07/10/2018

**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. This section is intended to supplement the requirements of Division 01 requirements. For any conflicting requirements for minimum quantities or quality levels between this Section and Division 01, comply with the most stringent requirement.

**1.2 SUMMARY**

- A. This Section includes the following when associated with Divisions 26, 27, and 28 work:
  - 1. Permits and fees.
  - 2. Code requirements.
  - 3. Work under other contracts.
  - 4. Work restrictions.
  - 5. Requests for Information (RFIs).
  - 6. Coordination.
  - 7. Coordination drawings.
  - 8. Conflicting requirements.
  - 9. Minor changes in the work.
  - 10. Quality assurance and control.
  - 11. Product delivery, storage, and handling.
  - 12. Product warranties.
  - 13. Submittal procedures.
  - 14. Record drawing and record digital files.
  - 15. Product selection procedures.
  - 16. Product interoperability requirements.
  - 17. Minimum contractor's commissioning responsibilities.
- B. Related Sections include the following:
  - 1. Division 01 Sections.

**1.3 PERMITS AND FEES**

- A. Give all necessary notices, obtain all permits; pay all government and state sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Project scope of 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 inspections for Project scope of work and deliver a copy to the Architect/Engineer before request for acceptance and final payment for the Project scope of work.

**1.4 CODE REQUIREMENTS**

- A. Project Code: Confirm the codes in effect at the time of permitting.
- B. Project Legislative Requirements: Confirm the State and Local Legislations in effect at the time of permitting or those that affect construction.
- C. Compliance: Comply with all codes and legislations applicable to the project, including energy related:
  - 1. Means and Methods
  - 2. Equipment and Devices.
  - 3. Materials and Work Product.

**1.5 WORK UNDER OTHER CONTRACTS**

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

**1.6 WORK RESTRICTIONS**

- A. Existing Utility Interruptions: 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:
1. Notify Construction Manager or Owner not less than 10 days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Construction Manager's or Owner's written permission.

**1.7 REQUESTS FOR INFORMATION (RFIs)**

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of Engineer, Architect and Construction Manager.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, product data, shop drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. The following RFIs will be returned without action:
1. Requests for approval of submittals.
  2. Requests for approval of substitutions.
  3. Requests for coordination information already indicated in the Contract Documents.
  4. Requests for adjustments in the Contract Time or the Contract Sum.
  5. Requests for interpretation of Architect's actions on submittals.
  6. Incomplete RFIs or inaccurately prepared RFIs.
- D. Action may include a request for additional information, in which case time for response will date from time of receipt of additional information.

## 1.8 COORDINATION

- A. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.
- B. Utility Coordination: Contractor shall coordinate all final specific utility requirements.
- C. Utilizing Two and Three Dimensional Information:
  - 1. Design Intent Model: The Design Intent Model has been developed to a Level of Development LOD 200 and LOD 300 Model Content Requirements as defined by AIA G-202-2013. The contract documents are solely a two dimensional set of documents. The Design Intent Model is a three dimensional tool utilized to create a two dimensional contract document. A two dimensional contract document requires, for reason of clarity and otherwise, that components of the design not be modeled in three dimensions and/or that the model be formed in a way that construction means and methods will dictate other ways of performing the installation. It is at the sole discretion of BVH Integrated Services, P.C. as to which portions of the design are modeled, which are not and to what degree each portion of the design requires coordination to convey design intent for contractual purposes. The Design Intent Model is not a substitute for the contractors' coordination process as outlined in the contract documents; full coordination remains the responsibility of this contractor and their sub-contractors. The contents of the model are not to be used for the basis of detailed cost estimating, coordinating equipment locations and systems routing with all other trades. The model does not include three dimensional detailed field survey work of existing conditions or new work in existing conditions. The contractor may use the Design Intent Model to help establish the backgrounds and/or starting point for the coordination drawings based on the stipulations of the release form that can be provided if and when the model is requested.
  - 2. Construction Coordination Model: The Construction Coordination Model shall be developed to a minimum Level of Development LOD 400 Model Content Requirements as defined by AIA G-202-2013. The contractor shall be fully responsible for creating and maintaining a Construction Coordination Model and coordination drawings as required for detailed construction installation and coordination with all other trades.
  - 3. Differences between the Design Intent Model and the Construction Coordination Model and/or actual installation location, means and methods are included in this contract and shall not constitute a change order on the basis of drawing, engineering and/or coordination time.

## 1.9 CONFLICTING REQUIREMENTS

- A. General: If compliance with two or more standards or directives is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

**1.10 MINOR CHANGES IN THE WORK**

- A. Engineer/Architect will issue through the Construction Manager, supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.
- B. Drawings are diagrammatic, the Contractor shall relocate devices a reasonable distance for coordination.
  - 1. A reasonable distance is considered to be 15 feet at no additional cost.

**1.11 QUALITY ASSURANCE AND CONTROL**

- A. General: Qualifications paragraphs in this Article establish some of the minimum qualification levels required; Division 01 and individual Specification Sections specify additional requirements.
- B. Code Compliance: Work and equipment shall comply with all latest applicable codes and legislations.
- C. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those required for this Project.
- D. Instructor Qualifications: A factory-authorized service representative, complying with requirements in "Quality Requirements," experienced in operation and maintenance procedures and training.
- E. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.
    - a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
  - 2. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
  - 3. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- F. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.
- G. Retesting/Reinspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- H. Associated Services: Cooperate with agencies performing required commissioning, tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Delivery of samples to testing agencies.
  - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - 7. Security and protection for samples and for testing and inspecting equipment at Project site.

- I. Coordination: Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- J. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
  - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
  - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used at no additional cost to the project.
- K. Acceptance of Work: 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 Code, Legislation, the Drawings and/or Specifications. Correct Work not in conformance whenever non-conformance is discovered.

#### **1.12 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions and generally accepted construction practice.
- B. Storage:
  - 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.
  - 3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
  - 4. Store cementitious products and materials on elevated platforms.
  - 5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
  - 6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
  - 7. Protect stored products from damage and liquids from freezing.
  - 8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

#### **1.13 PRODUCT WARRANTIES**

- A. Refer to Division 01 and individual sections for requirements.
- B. The following requirements are supplemental and in addition to those stated in other specific sections and Division 01.
  - 1. Warranty all materials and workmanship under these Specifications and the Contract for a period of one year from the date of final acceptance by the Owner.
  - 2. During this warranty period, correct or replace all defects developing through materials or workmanship immediately as directed by the Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction.
- C. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- D. Warranty Start Date: From the date of final acceptance by the Owner.

#### 1.14 SUBMITTAL PROCEDURES

- A. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
  - 1. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
- C. Substitution Requests: Submit four copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  - 1. Substitution: A submittal shall be considered a substitution when the Engineer/Architect does not accept the product or material as an "equivalent" or where one of the listed manufacturers is not submitted.
  - 2. Substitution Requirements: Substitutions shall meet the requirements of "Comparable Products."
  - 3. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified material or product cannot be provided.
    - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.
    - c. Detailed comparison of significant qualities of proposed substitution with those of the Project scope of work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
    - d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
    - e. Samples, where applicable or requested.
    - f. Cost information, including a proposal of change, if any, in the Contract Sum.
    - g. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
    - h. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
    - i. Statement indicating why the requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations.

#### 1.15 RECORD DRAWINGS AND RECORD DIGITAL FILES

- A. Record Drawings and Record Digital Files: Comply with the following:
  - 1. Submit Record Drawings and Record Digital Files as follows:
    - a. Initial Submittal: Submit one set of plots from corrected Record CAD Drawings and one set of marked-up Record Prints. Engineer will initial and date each plot and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. Engineer will return plot for organizing into sets, printing, binding, and final submittal.
    - b. Final Submittal: Submit one set(s) of marked-up Record Prints.
    - c. Final Submittal: Submit three sets of Record CAD Drawing files and one set of Record CAD Drawing plots. Plot and print each drawing, whether or not changes and additional information were recorded.
      - 1) Electronic Media: CD-R.

- B. Qualification Data: For training instructor.

#### 1.16 PRODUCT SELECTION PROCEDURES

- A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
4. Where products are accompanied by the term "as selected," Engineer and/or Architect will make selection.
5. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
6. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

- B. Product Selection Procedures:

1. Design Basis: The design has been based on the single manufacturer indicated in the contract documents. The Contractor is responsible for verifying prior to submission, that any other manufacturer even though listed complies with dimensional and performance characteristics of the base specified product. Modifications shall be made by the Contractor as part of this contract to accommodate changes to the design basis.
2. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
3. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
4. Equivalent Product: Equipment, material or devices submitted for review as an "accepted equivalent" shall meet all of the following requirements:
  - a. A product of a listed manufacturer.
  - b. The equivalent shall have the same construction features such as, but not limited to:
    - 1) Material thickness, gauge, weight, density, etc.
    - 2) Welded, riveted, bolted, etc., construction
    - 3) Finish, undercoating, corrosion protection
  - c. The equivalent shall perform with the same or better operating efficiency.
  - d. The equivalent shall have equal or greater reserve capacity.
  - e. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  - f. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL, AMCA or ARI labels.

#### 1.17 PRODUCT INTEROPERABILITY REQUIREMENTS

- A. Interoperability Coordination Meeting: Attend a minimum of 3 weekly coordination meetings to coordinate interoperability between all systems and equipment. Meetings shall be scheduled by the construction manager.
- B. General Networking and Protocol Interoperability Requirements: Provide products that are fully BACNet interoperable.



1. All systems and equipment shall interface with the primary building management network provided under "Instrumentation and Controls for HVAC" using Ethernet standards and BACNet protocol.
  2. Equipment that is native BACNet may connect directly to a BACNet MS/TP subnet that is provided by "Instrumentation and Controls for HVAC" when coordinated with that Section Contractor.
  3. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to the most current ANSI/ASHRAE Standard 135, BACnet.
  4. The MS/TP trunks support all of the ASHRAE 135 approved baud rates.
  5. All MS/TP devices support all baud rates of the ASHRAE 135.
  6. All MS/TP devices shall be BTL approved ( BACnet Testing Lab).
  7. All BACnet routers must support B-BC (BIBB) and support BBMD routing.
  8. Lonworks and Modbus subnets may be utilized where no BACNet protocol is available provided full 2-way compatibility is provided through a gateway.
    - a. Exception: Fire alarm systems shall be 1-way, read only communication.
  9. Each individual system and/or equipment manufacturer/installer shall provide all necessary gateways/translators Provide Gateway with all products as required facilitating full BACNet interoperability with BACNet Protocol.
  10. It must be possible to read and display the value of any property, including all required properties, supported optional properties, and proprietary extensions of very object of every networked device.
  11. Operating setpoints and parameters must be available for modification via BACnet services via a graphical user interface (GUI).
  12. An operator shall be able to display at any time the operational status of any device on the BACnet internetwork. An operator shall be able to display at any time any property of any BACnet object. An operator shall also be able to display property values of objects grouped by object type, object location, building system, and by user defined parameters.
  13. An operator shall have the ability to issue re-initialization commands to any device that supports remote re-initialization.
  14. An operator shall have the ability to backup and restore all BACnet devices on the network.
  15. It shall be each contractor's responsibility to configure each router using the network numbering scheme for the project. Each router shall be configured such that all network layer error messages shall be directed to a specific workstation using the BACnet Confirmed Text Message service. It shall be the contractor's responsibility to initially configure each router with routing tables containing all network numbers that are part of the project's internet. The router shall be able to receive messages at each port of any length that is valid for the LAN technology connected to that port, and to forward the message to any directly-connected network that can convey a message of that size.
  16. Legacy Systems: Bi-directional gateways shall be provided for systems and equipment operating on a legacy/proprietary system. The operator workstation shall display information from both the BACnet and non-BACnet devices. Any information specified or required for system functionality shall be made readable and modifiable. Gateways shall have 10% expansion capacity. Gateways shall support archiving, uploading, trending, scheduling, and alarm/event detection, notification and acknowledgement.
  17. Systems and equipment shall have full 2- way communications and interoperability.
    - a. Exception: Fire safety systems and equipment shall have only read access to outside systems:
      - 1) Fire alarm.
  18. Coordinate with "Instrumentation and Controls for HVAC" and other building operational systems for specific interoperability requirements.
- C. Communications Standard: Coordinate communications standards requirements with other Sections and Divisions.
1. MS/TP LAN: RS 485
  2. Systems with dedicated network(s) shall connect on the BACNet Ethernet LAN: utilizing a switch and shall meet standard Ethernet requirements.

- a. Utilize RJ-45 terminations.
  - b. Utilize CAT 6 cabling.
  - c. Meet IEEE Standard 802.3 standards and requirements.
  - d. Speed: 100 Mbps.
3. Equipment without dedicated networks shall connect to the BACNet MS/TP LAN.
- a. RS 485 communications standard.
  - b. Speed: 1 Mbps.
- D. Information Availability: Make all product information, points, variables, setpoints, etc., available for access of building operational systems upon request.
1. Provide bi-directional point mapping/addressing instructions.
  2. Provide on-site technicians as required to ensure proper information exchange.
- E. Factory Provided Equipment Controllers: Provide all information, points, variables, setpoints, etc., indicated and referenced in all documentation, including "Instrumentation and Controls for HVAC." Products shall have full interoperability as indicated in this Section, in BACNet standards and elsewhere.

### 1.18 MINIMUM CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- A. Each Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
  2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
  3. Attend commissioning team meetings held on a weekly basis.
  4. Integrate and coordinate commissioning process activities with construction schedule.
  5. Review and accept construction checklists provided by the CxA.
  6. Complete paper or electronic construction checklists as Work is completed and provide to the Commissioning Authority on a weekly basis.
  7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
  8. Complete commissioning process test procedures.
- B. Refer to related information in other sections for additional requirements.

## PART 2 - PRODUCTS

### 2.1 SHOP DRAWINGS

- A. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed or electronic data.
1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
    - a. Identification of products.
    - b. Schedules.
    - c. Compliance with specified standards.
    - d. Notation of coordination requirements.
    - e. Notation of dimensions established by field measurement.
    - f. Relationship and attachment to adjoining construction clearly indicated.
    - g. Seal and signature of professional engineer if specified.

2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

## 2.2 RECORD DRAWINGS

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
  1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an understandable drawing technique.
    - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Revisions to details shown on Drawings.
    - b. Locations and depths of underground system entities.
    - c. Revisions to routing of piping.
    - d. Actual equipment locations.
    - e. Duct size and routing.
    - f. Locations of concealed internal utilities.
    - g. Changes made by Change Order or Change Directive.
    - h. Changes made following Engineer's written orders.
    - i. Details not on the original Contract Drawings.
    - j. Field records for variable and concealed conditions.
    - k. Record information on the Project scope of work that is shown only schematically.
  3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  4. Mark record sets with erasable, colored pencil. Use multiple colors to distinguish between changes for different categories of the Work at same location.
  5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record CAD Drawings: Immediately before observation for Certificate of Substantial Completion, review marked-up Record Prints with Engineer and Construction Manager. When authorized, prepare a full set of corrected CAD Drawings of the Contract Drawings, as follows:
  1. Format: DWG or Revit format of the same version, and operating system as the original Contract Drawings.
  2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.
  3. Refer instances of uncertainty to Engineer for resolution.
  4. Contractor may request one set of CAD Drawings of the Contract Drawings for use in recording information.
    - a. Engineer makes no representations as to the accuracy or completeness of CAD Drawings as they relate to the Contract Drawings.
- C. Construction Coordination Building Information Model:
  1. Prepare Construction Coordination Building Information Model for the project utilizing Autodesk Revit software.

2. Construction coordination model to reflect the as-installed conditions of the project and the characteristics of installed equipment.
- D. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Record CAD/Revit Drawings: Organize information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each file.
  3. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Engineer, Architect and Construction Manager.
    - e. Name of Contractor.

### **2.3 RECORDING AND MAINTENANCE**

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

### **2.4 TRAINING AND INSTRUCTION PROGRAM**

- A. Program Structure: In addition to Division 01 and individual section requirements, develop an instruction program that includes individual training modules for each system and equipment not part of a system.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. Provide instruction for the following modules.
1. Basis of System Design and Operational Requirements
  2. Documentation
  3. Emergencies
  4. Adjustments
  5. Troubleshooting
  6. Maintenance
  7. Repairs
- C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
- D. Video Record: Training shall be recorded as video.
1. Format: Standard DVD format.
  2. Quantity: Three discs of each individual DVD.
  3. Labeling: Label each DVD with it's library of training sections based on equipment type and system type.

## 2.5 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Engineer/Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer/Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utility and system connections.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
  3. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Written Report: Where a written report listing conditions detrimental to performance of the Project scope of work is required by other Sections, include the following:
    - a. Description of the Work.
    - b. List of detrimental conditions, including substrates.
    - c. List of unacceptable installation tolerances.
    - d. Recommended corrections.
  2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

### 3.2 PREPARATION

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

### 3.3 DEMOLITION

- A. Work indicated to be removed includes removal of all auxiliary materials, accessories, anchorage, fasteners, and etc., down to bare substrate. No residual materials shall remain from work to be removed. Contractor will use whatever means necessary; including removal of all materials attached or related to those items designated to be removed, as acceptable to Owner and Engineer, to provided complete and thorough removal of existing work.
- B. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.
- D. Abandoned Work: Cut and remove buried MEP system materials, equipment, raceways, piping and distribution, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
- E. Remove demolished materials from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Field verify all existing MEP system materials, equipment, raceways, piping and distribution to be removed for exact quantities.
- H. Remove all existing MEP system materials, equipment, raceways, piping and distribution located above ceilings and in walls that are not being reused.
- I. Remove all MEP systems and appurtenances, which are to be removed, in their entireties back to the source or source panels.
- J. Remove all existing MEP system materials, equipment, raceways, piping and distribution located in walls or ceilings being demolished. Abandon no devices that have been disconnected unless specifically noted.
- K. Maintain continuity of all existing MEP devices, and utilization equipment not removed.
- L. Remove, store, protect, and reinstall existing work as required to accommodate alteration indicated.

- M. The existing work to be removed, in general, is as indicated on the Drawings and in this Section, but also includes any materials or work necessary to permit installation of new materials, as approved by Owner and Engineer.
  
- N. Disconnect, demolish, and remove systems, equipment, and components indicated to be removed, abandoned or as made obsolete by this project.
  - 1. To Be Removed: Remove portion of systems, equipment, and components indicated to be removed and cap or plug remaining with same or compatible material.
  - 2. To Be Abandoned in Place: Drain piping and cap or plug systems, equipment, and components with same or compatible material.
  - 3. Equipment to Be Removed: Disconnect, make safe and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect, make safe and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect, make safe and cap services and remove equipment and deliver at direction of Owner.
  
- O. If systems, equipment, and components to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
  
- P. In finished areas, all systems, equipment, and components shall be cut back to a concealed location, i.e., within walls, above ceilings, etc., before capping.

### **3.4 INSTALLATION**

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
  - 4. Maintain minimum headroom clearance as indicated by Architect and/or Construction Manager in spaces without a suspended ceiling.
  
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
  
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
  
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
  
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
  
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
  
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
  - 1. All electrical equipment and piping not supported from the building structural steel shall not exceed a combined load of 7 psf when supported from the metal deck/slab. Any condition that may exceed this limit shall be reviewed and approved by the Design-Builder and Structure Engineer before installation.

2. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer and/or to allow for proper access.
  3. Allow for building movement, including thermal expansion and contraction.
  4. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### **3.5 CUTTING AND PATCHING**

- A. See Division 01 for additional requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of Work.
- B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the floors and walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed, where wall or floors are existing or not correctly located. The Contractor shall do all drilling required for the installation of hangers.
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### **3.6 SCAFFOLDING, RIGGING, HOISTING**

- A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

### **3.7 EXCAVATION AND BACKFILLING**

- A. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division.

### **3.8 ACCESSIBILITY AND ACCESS PANELS**

- A. The Contractor shall be responsible for the sufficiency of the size of shafts and chases, the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the Work.
- B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Access doors in walls, ceilings, floors, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.



- D. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- E. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.

**3.9 STARTING AND ADJUSTING**

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect field-assembled components and equipment installation, comply with qualification requirements in "Quality Requirements."

**3.10 PROTECTION OF INSTALLED CONSTRUCTION**

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.
- C. Remove debris from concealed spaces before enclosing the space.
- D. Remove liquid spills promptly.
- E. Where dust would impair proper execution of the Project scope of work, broom-clean or vacuum the entire work area, as appropriate.
- F. Installed Work: Keep installed work clean.
- G. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

**3.11 CORRECTION OF THE WORK**

- A. The cost of corrective work shall be included under the contract.

- B. Repair or remove and replace defective construction.
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- C. Restore permanent facilities used during construction to their specified or original condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components to new condition.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

**END OF SECTION 27 00 10**  
07/10/2018

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**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. Metal conduits and fittings.
  - 2. Nonmetallic conduits and fittings.
  - 3. Metal wireways and auxiliary gutters.
  - 4. Nonmetallic wireways and auxiliary gutters.
  - 5. Boxes, enclosures, and cabinets.
- B. Related Requirements:
  - 1. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.
  - 2. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
  - 3. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

**1.3 DEFINITIONS**

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid steel conduit.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For surface pathways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.
- B. LEED Submittals:
  - 1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.
  - 2. Laboratory Test Reports for Credit IEQ 4: For solvent cements and adhesive primers, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- C. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Pathway routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:
  - 1. Structural members in paths of pathway groups with common supports.
  - 2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

- B. Qualification Data: For professional engineer.
- C. Seismic Qualification Certificates: For pathway racks, enclosures, cabinets, equipment racks and their mounting provisions, including those for internal 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.
  - 3. Detailed description of equipment anchorage devices on which certification is based and their installation requirements.
  - 4. Detailed description of conduit support devices and interconnections on which certification is based and their installation requirements.
- D. Source quality-control reports.

## **1.6 COORDINATION**

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets and suspension system with other construction that penetrates ceilings or is supported by them, including luminaires, HVAC equipment, fire suppression system, and partition assemblies.

## **PART 2 - PRODUCTS**

### **2.1 METAL CONDUITS AND FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems; a part of Atkore International.
  - 2. Allied Tube & Conduit; a part of Atkore International.
  - 3. Alpha Wire.
  - 4. Electri-Flex Company.
  - 5. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 6. Picoma Industries, Inc.
  - 7. Republic Conduit.
  - 8. Robroy Industries.
  - 9. Southwire Company.
  - 10. Thomas & Betts Corporation, A Member of the ABB Group.
  - 11. Western Tube and Conduit Corporation.
  - 12. Wheatland Tube Company.
- B. General Requirements for Metal Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. ARC: Comply with ANSI C80.5 and UL 6A.
- E. EMT: Comply with ANSI C80.3 and UL 797.
- F. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
  - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
  - 2. Fittings for EMT:
    - a. Material: Steel.

- b. Type: Setscrew or compression.
- 3. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.
- G. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

**2.2 NONMETALLIC CONDUITS AND FITTINGS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. AFC Cable Systems; a part of Atkore International.
  - 2. Allied Tube & Conduit; a part of Atkore International.
  - 3. CANTEX INC.
  - 4. Carlon; a brand of Thomas & Betts Corporation.
  - 5. Electri-Flex Company.
  - 6. Kraloy.
  - 7. Niedax Inc.
  - 8. RACO; Hubbell.
  - 9. Thomas & Betts Corporation, A Member of the ABB Group.
- B. General Requirements for Nonmetallic Conduits and Fittings:
  - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
  - 2. Comply with TIA-569-B.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Solvent cements and adhesive primers shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

**2.3 BOXES, ENCLOSURES, AND CABINETS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Carlon; a brand of Thomas & Betts Corporation.
  - 2. Crouse-Hinds, an Eaton business.
  - 3. EGS/Appleton Electric.
  - 4. FSR Inc.
  - 5. Hoffman; a brand of Pentair Equipment Protection.
  - 6. Milbank Manufacturing Co.
  - 7. Molex Industrial Products Group; Woodhead Brand.
  - 8. MonoSystems, Inc.
  - 9. Oldcastle Enclosure Solutions.
  - 10. O-Z/Gedney; a brand of Emerson Industrial Automation.
  - 11. Quazite: Hubbell Power Systems, Inc.
  - 12. RACO; Hubbell.
  - 13. Spring City Electrical Manufacturing Company.
  - 14. Thomas & Betts Corporation, A Member of the ABB Group.
  - 15. Wiremold / Legrand.

- B. General Requirements for Boxes, Enclosures, and Cabinets:
  - 1. Comply with TIA-569-B.
  - 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.
- E. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum galvanized, cast iron with gasketed cover.
- H. Gangable boxes are prohibited.
- I. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- J. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1, Type 3R, Type 4 or, Type 12 with continuous-hinge cover with flush latch unless otherwise indicated.
  - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
  - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- K. Cabinets:
  - 1. NEMA 250, Type 1, Type 3R, or, Type 12, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
  - 2. Hinged door in front cover with flush latch and concealed hinge.
  - 3. Key latch to match panelboards.
  - 4. Metal barriers to separate wiring of different systems and voltage.
  - 5. Accessory feet where required for freestanding equipment.
  - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

### **PART 3 - EXECUTION**

#### **3.1 PATHWAY APPLICATION**

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Exposed Conduit: GRC.
  - 2. Concealed Conduit, Aboveground: GRC.
  - 3. Underground Conduit: RNC, Type EPC-80-PVC, direct buried.
  - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
  - 1. Exposed, Not Subject to Physical Damage: EMT.
  - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
  - 3. Exposed and Subject to Severe Physical Damage: GRC. Pathway locations include the following:
    - a. Loading dock.
    - b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
    - c. Mechanical rooms.
    - d. Gymnasiums

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
  5. Damp or Wet Locations: GRC.
- C. Pathway Fittings: Compatible with pathways and suitable for use and location.
1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
  2. EMT: Comply with NEMA FB 2.10.
    - a. Utilize steel compression fittings in the following locations:
      - 1) Damp locations.
      - 2) Boiler rooms.
      - 3) Mechanical rooms.
      - 4) Within block walls.
    - b. Utilize steel set-screw fittings in the following locations:
      - 1) Dry locations.
      - 2) Above suspended ceilings.
      - 3) Within stud walls.
- D. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- E. Install surface pathways only where indicated on Drawings.
- F. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

### 3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Complete pathway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
  1. Whenever any raceway crosses an expansion or seismic joint, provide a pull box on each side of the joint with sufficient length of flexible raceway to accommodate movement in all directions. See section regarding seismic control for electrical work for additional requirements. Coordinate movement requirements at expansion and seismic joints with Structural Engineer of Record.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction.
- G. Conceal pathway and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support pathway within 12 inches of enclosures to which attached.



- I. Stub-ups to Above Recessed Ceilings:
  - 1. Use RMC for pathways.
  - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
  
- J. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of pathway and fittings before making up joints. Follow compound manufacturer's written instructions.
  
- K. Join raceways with fittings designed and approved for that purpose and make joints tight.
  - 1. Use insulating bushings to protect conductors. Within return air plenums, utilize plenum rated bushings.
  
- L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install insulated bushings on conduits terminated with locknuts.
  
- M. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
  
- N. Cut conduit perpendicular to the length. For conduits of 2-inch trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
  
- O. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Within return air plenums, utilize a #10 AWG conductor in place of a plastic line. Cap underground pathways designated as spare above grade alongside pathways in use.
  
- P. Surface Pathways:
  - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
  - 2. Install surface pathway with a minimum 2-inch radius control at bend points.
  - 3. Secure surface pathway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight pathway section. Support surface pathway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
  
- Q. Install pathway sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway sealing fittings according to NFPA 70.
  
- R. Install devices to seal pathway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
  - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
  - 2. Where an underground service pathway enters a building or structure.
  - 3. Where otherwise required by NFPA 70.
  
- S. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
  
- T. Expansion-Joint Fittings:
  - 1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F, and that has straight-run length that exceeds 25 feet. Install in each run of

- aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
    - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
    - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
    - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
    - d. Attics: 135 deg F temperature change.
  3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F of temperature change for metal conduits.
  4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
  5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.
- U. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- V. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- W. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- X. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- Y. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- Z. Set metal floor boxes level and flush with finished floor surface.
- AA. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- 3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS**
- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."
- 3.4 FIRESTOPPING**
- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
- 3.5 PROTECTION**
- A. Protect coatings, finishes, and cabinets from damage or deterioration.
    1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

**END OF SECTION 27 05 28**  
07/10/2018

**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. Sleeves for pathway and cable penetration of non-fire-rated construction walls and floors.
  - 2. Sleeve-seal systems.
  - 3. Sleeve-seal fittings.
  - 4. Grout.
  - 5. Silicone sealants.
- B. Related Requirements:
  - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

**1.3 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
- B. LEED Submittals:
  - 1. Product Data for Credit EQ 4.1: For sealants, documentation including printed statement of VOC content.
  - 2. Laboratory Test Reports for Credit EQ 4: For sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

**PART 2 - PRODUCTS**

**2.1 SLEEVES**

- A. Wall Sleeves:
  - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
  - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.
- C. PVC-Pipe Sleeves: ASTM D 1785, Schedule 40.
- D. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.
- E. Molded-PE or -PP Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

F. Sleeves for Rectangular Openings:

1. Material: Galvanized-steel sheet.
2. Minimum Metal Thickness:
  - a. For sleeve cross-section rectangle perimeter less than 50 inches and with no side larger than 16 inches, thickness shall be 0.052 inch.
  - b. For sleeve cross-section rectangle perimeter equal to, or more than 50 inches or more and one or more sides equal to, or more than 16 inches, thickness shall be 0.138 inch.

**2.2 SLEEVE-SEAL SYSTEMS**

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Advance Products & Systems, Inc.
  - b. CALPICO, Inc.
  - c. HOLDRITE.
  - d. Metraflex Company (The).
  - e. Pipeline Seal and Insulator, Inc.
  - f. Proco Products, Inc.
2. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

**2.3 SLEEVE-SEAL FITTINGS**

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
  - a. Flexicraft Industries.
  - b. HOLDRITE.
  - c. Link-Seal.

**2.4 GROUT**

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

**2.5 SILICONE SEALANTS**

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
  2. Sealant shall have VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
  3. Sealant shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

**PART 3 - EXECUTION****3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS**

- A. Comply with NECA 1.
- B. Sleeves shall be fastened securely to the assembly that it penetrates.
- C. Comply with NEMA VE 2 for cable tray and cable penetrations.
- D. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
    - a. Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
    - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.
  2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
  3. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and pathway or cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.
  4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
  5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches above finished floor level. Install sleeves during erection of floors.
- E. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
  2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- F. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- G. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- H. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between pathway or cable and sleeve for installing sleeve-seal system.

**3.2 SLEEVE-SEAL-SYSTEM INSTALLATION**

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at pathway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

**3.3 SLEEVE-SEAL-FITTING INSTALLATION**

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

**3.4 SLEEVE INSTALLATION FOR FIRE-RATED COMMUNICATIONS PENETRATIONS**

- A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 078413 "Penetration Firestopping."
- B. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.
- C. Fire-Rated Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials.

**END OF SECTION 27 05 44**  
07/10/2018

**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. UTP cable.
  - 2. UTP cable hardware.
  - 3. Grounding.
  - 4. Identification products.
- B. Related Requirements:
  - 1. Section 271100 "Communications Equipment Room Fittings" for arrangement of pathways and fittings.

**1.3 DEFINITIONS**

- A. BICSI: Building Industry Consulting Service International.
- B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- C. EMI: Electromagnetic interference.
- D. ER: Equipment room.
- E. IDC: Insulation displacement connector.
- F. LAN: Local area network.
- G. RCDD: Registered Communications Distribution Designer.
- H. TDMM: Telecommunications distribution methods manual.
- I. Telecommunications Outlet/Connector: A connecting device in the work area on which horizontal cable terminates.
- J. TR: Telecommunications room.
- K. UTP: Unshielded twisted pair.

**1.4 PERFORMANCE REQUIREMENTS**

- A. General Performance: Horizontal cabling system shall comply with transmission standards in ANSI/TIA-568-C.1 when tested according to test procedures of this Standard.
- 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 application.
- C. Grounding: Comply with ANSI/TIA-607-B.



**1.5 ADMINISTRATIVE REQUIREMENTS**

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.
- C. Coordinate telecommunications outlet/connector locations with walls, furniture, millwork, surface-mounted raceway and specialty locations at each work area.

**1.6 ACTION SUBMITTALS**

- A. Product Data: For each type of product, including but not limited to UTP cable, UTP cable hardware, coaxial cable hardware, telecommunications outlet/connectors and identification products.
- B. Shop Drawings:
  - 1. Cabling administration drawings and printouts.
  - 2. Wiring diagrams to show typical wiring schematics, including the following:
    - a. Cross-connects.
    - b. Horizontal cable.
    - c. Patch panels.
    - d. Riser cable.
  - 3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

**1.7 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For Installer, qualified layout technician, and installation supervisor.
- B. Intended Warranty Program: Blank form provided by manufacturer intended to be used during the warranty section of the project.

**1.8 CLOSEOUT SUBMITTALS**

- A. Maintenance Data: Include in maintenance manuals.

**1.9 QUALITY ASSURANCE**

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
  - 1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by a BICSI-certified RCDD. An RCDD stamp and signature shall accompany the shop drawing cover sheet.
  - 2. Installation Supervision: Installation shall be under the direct supervision of a BICSI-certified ITS technician, who shall be present at all times when Work of this Section is performed at Project site.

**1.10 DELIVERY, STORAGE, AND HANDLING**

- A. Test cables upon receipt at Project site.

**1.11 WARRANTY**

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace horizontal UTP cabling and components that fail within specified warranty period.

1. Warranty Period: Twenty years from date of Substantial Completion.

## **PART 2 - PRODUCTS**

### **2.1 UTP CABLE**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Belden.
  2. CommScope.
  3. General Cable.
  4. Hitachi.
  5. Mohawk.
  6. Siemon.
  7. Superior Essex Inc.
  
- B. Description: 100-ohm, four-pair UTP, covered with a blue thermoplastic jacket.
  1. Comply with ANSI/TIA-568-C.2, Category 6.
  2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
    - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

### **2.2 UTP CABLE HARDWARE**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Belden.
  2. CommScope.
  3. Hubbell Premise Wiring.
  4. Leviton.
  5. Panduit.
  6. Siemon.
  
- B. General Requirements for Cable Connecting Hardware: Comply with ANSI/TIA-568-C.2, Category 6, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
  
- C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
  
- D. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.
  1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus 15 percent spare.
  
- E. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA-568-C.2, Category 6.
  
- F. Faceplates: Single or multi-gang faceplate.
  1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
  2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
  3. For use with snap-in jacks accommodating any combination of UTP and coaxial work area cords.
    - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
  4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

**2.3 GROUNDING**

- A. Comply with requirements in Section 270526 "Grounding and Bonding for Communications Systems" for grounding conductors and connectors.
- B. Comply with ANSI/TIA-607-B.

**2.4 IDENTIFICATION PRODUCTS**

- A. Comply with ANSI/TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

**PART 3 - EXECUTION**

**3.1 WIRING METHODS**

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
  - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
  - 2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
  - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
  - 2. Install lacing bars and distribution spools.
  - 3. Install conductors parallel with or at right angles to sides and back of enclosure.

**3.2 INSTALLATION OF CABLES**

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
  - 1. Comply with ANSI/TIA-568-C.2.
  - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
  - 3. Install 110-style IDC termination hardware unless otherwise indicated.
  - 4. Terminate conductors; no cable shall contain unterminated elements unless otherwise noted. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
  - 5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
  - 6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
  - 7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
  - 8. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
  - 9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
  - 10. In the equipment room, telecommunications room, or telecommunications enclosure, install a 10-foot- long service loop.
  - 11. In the ceiling at the work area outlet, install a 3.28-ft. long service loop.
  - 12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

- C. UTP Cable Installation:
  - 1. Comply with ANSI/TIA-568-C.2.
  - 2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.
  
- D. Open-Cable Installation:
  - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
  - 2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
  - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
  
- E. Group connecting hardware for cables into separate logical fields.
  
- F. Separation from EMI Sources:
  - 1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
  - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
  - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
  - 4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
    - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
  - 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
  - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

### 3.3 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with ANSI/TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

### 3.4 GROUNDING

- A. Install grounding according to BICSI TDMM, "Bonding and Grounding (Earthing)" Chapter.
- B. Comply with ANSI/TIA-607-B.

- C. Locate telecommunications grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

**3.5 IDENTIFICATION**

- A. Coordinate names, abbreviations, and other designations used in telecommunications identification scheme with Owner's desired identification scheme, regardless of numbering indicated on the drawings and specifications.
- B. Identify system components, wiring, and cabling complying with TIA/EIA-606-A.
  - 1. Administration Class: 2.
  - 2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.
- C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.
- E. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications rooms, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.
- F. Cable and Wire Identification:
  - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
  - 2. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
    - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    - b. Label each unit and field within distribution racks and frames.
  - 3. Identification within Connector Fields in Equipment Rooms and Telecom Rooms: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
- G. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
  - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

**3.6 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with ANSI/TIA-568-C.2.
  2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
  3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
  4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
    - a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
  5. UTP Performance Tests:
    - a. Test each outlet. Perform the following tests according to ANSI/TIA-568-C.2:
      - 1) Wire map.
      - 2) Length (physical vs. electrical, and length requirements).
      - 3) DC loop resistance.
      - 4) Return loss.
      - 5) Insertion loss.
      - 6) ACRF.
      - 7) PSACRF.
      - 8) Propagation delay skew.
      - 9) PSANEXT loss.
      - 10) Average PSANEXT loss.
      - 11) PSAACRF.
      - 12) Average PSAACRF loss.
      - 13) Return loss.
      - 14) Propagation delay.
- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 11 in BICSI TDMM, and/or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

**3.7 DEMONSTRATION**

- A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

**END OF SECTION 27 15 00**  
07/10/2018

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**PART 1 - GENERAL**

**1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
- B. This section is intended to supplement the requirements of Division 01 requirements. For any conflicting requirements for minimum quantities or quality levels between this Section and Division 01, comply with the most stringent requirement.

**1.2 SUMMARY**

- A. This Section includes the following when associated with Divisions 26, 27, and 28 work:
  - 1. Permits and fees, code requirements, work under other contracts.
  - 2. Work restrictions.
  - 3. Specification formats and conventions.
  - 4. Request for information.
  - 5. Coordination.
  - 6. Conflicting requirements.
  - 7. Quality assurance and control.
  - 8. Product delivery, storage, and handling.
  - 9. Product warranties.
  - 10. Submittals.
  - 11. Product selection procedures.
  - 12. Product interoperability requirements.
  - 13. General execution of project scope of work.
  - 14. Record drawings.
  - 15. Demonstration and training.

- B. Related Sections include the following:
  - 1. Division 01 Sections.

**1.3 PERMITS AND FEES**

- A. Give all necessary notices, obtain all permits; pay all government and state sales taxes and fees where applicable, and other costs, including utility connections or extensions in connection with the Project scope of 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 inspections for Project scope of work and deliver a copy to the Architect/Engineer before request for acceptance and final payment for the Project scope of work.

**1.4 CODE REQUIREMENTS**

- A. Project Code: Confirm the codes in effect at the time of permitting.
- B. Project Legislative Requirements: Confirm the State and Local Legislations in effect at the time of permitting or those that affect construction.
- C. Compliance: Comply with all codes and legislations applicable to the project, including energy related:
  - 1. Means and Methods
  - 2. Equipment and Devices.
  - 3. Materials and Work Product.



**1.5 WORK UNDER OTHER CONTRACTS**

- A. General: Cooperate fully with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate the Work of this Contract with work performed under separate contracts.

**1.6 WORK RESTRICTIONS**

- A. Existing Utility Interruptions: 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:
1. Notify Construction Manager or Owner not less than 10 days in advance of proposed utility interruptions.
  2. Do not proceed with utility interruptions without Construction Manager's or Owner's written permission.

**1.7 REQUESTS FOR INFORMATION (RFIs)**

- A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.
1. Coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of subcontractors.
- B. Content of the RFI: Include a detailed, legible description of item needing information or interpretation and the following:
1. Project name.
  2. Project number.
  3. Date.
  4. Name of Contractor.
  5. Name of Engineer, Architect and Construction Manager.
  6. RFI number, numbered sequentially.
  7. RFI subject.
  8. Specification Section number and title and related paragraphs, as appropriate.
  9. Drawing number and detail references, as appropriate.
  10. Field dimensions and conditions, as appropriate.
  11. Contractor's suggested resolution.
  12. Contractor's signature.
  13. Attachments: Include sketches, descriptions, measurements, photos, product data, shop drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
    - a. Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.
- C. The following RFIs will be returned without action:
1. Requests for approval of submittals.
  2. Requests for approval of substitutions.
  3. Requests for coordination information already indicated in the Contract Documents.
  4. Requests for adjustments in the Contract Time or the Contract Sum.
  5. Requests for interpretation of Architect's actions on submittals.
  6. Incomplete RFIs or inaccurately prepared RFIs.
- D. Action may include a request for additional information, in which case time for response will date from time of receipt of additional information.

**1.8 COORDINATION**

- A. Coordination: Each Contractor shall coordinate its construction operations with those of other Contractors and entities to ensure efficient and orderly installation of each part of the Work. Each Contractor shall coordinate its operations with operations, included in different Sections that depend on each other for proper installation, connection, and operation.
  - 1. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
  - 2. Coordinate installation of different components with other Contractors to ensure maximum performance and accessibility for required maintenance, service, and repair.
  - 3. Make adequate provisions to accommodate items scheduled for later installation.

**1.9 CONFLICTING REQUIREMENTS**

- A. General: If compliance with two or more standards or directives is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Architect/Engineer for a decision before proceeding.
- B. Minimum Quantity or Quality Levels: The quantity or quality level shown or specified shall be the minimum provided or performed. The actual installation may comply exactly with the minimum quantity or quality specified, or it may exceed the minimum within reasonable limits. To comply with these requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Engineer for a decision before proceeding.

**1.10 MINOR CHANGES IN THE WORK**

- A. Engineer/Architect will issue through the Construction Manager, supplemental instructions authorizing minor changes in the Work, not involving adjustment to the Contract Sum or the Contract Time.
- B. Drawings are diagrammatic, the Contractor shall relocate devices a reasonable distance for coordination.
  - 1. A reasonable distance is considered to be 15 feet at no additional cost.

**1.11 QUALITY ASSURANCE AND CONTROL**

- A. General: Qualifications paragraphs in this Article establish some of the minimum qualification levels required; Division 01 and individual Specification Sections specify additional requirements.
- B. Code Compliance: Work and equipment shall comply with all latest applicable codes and legislations.
- C. Factory-Authorized Service Representative Qualifications: An authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products that are similar in material, design, and extent to those required for this Project.
- D. Instructor Qualifications: A factory-authorized service representative, complying with requirements in "Quality Requirements," experienced in operation and maintenance procedures and training.
- E. Tests and inspections not explicitly assigned to Owner are Contractor's responsibility. Unless otherwise indicated, provide quality-control services specified and those required by authorities having jurisdiction. Perform quality-control services required of Contractor by authorities having jurisdiction, whether specified or not.
  - 1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these quality-control services.

- a. Contractor shall not employ same entity engaged by Owner, unless agreed to in writing by Owner.
- 2. Testing and inspecting requested by Contractor and not required by the Contract Documents are Contractor's responsibility.
- 3. Submit additional copies of each written report directly to authorities having jurisdiction, when they so direct.
- F. **Manufacturer's Field Services:** Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.
- G. **Retesting/Reinspecting:** Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and reinspecting, for construction that replaced Work that failed to comply with the Contract Documents.
- H. **Associated Services:** Cooperate with agencies performing required commissioning, tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide the following:
  - 1. Access to the Work.
  - 2. Incidental labor and facilities necessary to facilitate tests and inspections.
  - 3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
  - 4. Facilities for storage and field curing of test samples.
  - 5. Delivery of samples to testing agencies.
  - 6. Preliminary design mix proposed for use for material mixes that require control by testing agency.
  - 7. Security and protection for samples and for testing and inspecting equipment at Project site.
- I. **Coordination:** Coordinate sequence of activities to accommodate required quality-assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting.
  - 1. Schedule times for tests, inspections, obtaining samples, and similar activities.
- J. **Compatibility of Options:** If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.
  - 1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.
  - 2. If a dispute arises between contractors over concurrently selectable but incompatible products, Engineer will determine which products shall be used at no additional cost to the project.
- K. **Acceptance of Work:** 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 Code, Legislation, the Drawings and/or Specifications. Correct Work not in conformance whenever non-conformance is discovered.

**1.12 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver, store, and handle products using means and methods that will prevent damage, deterioration, and loss, including theft. Comply with manufacturer's written instructions and generally accepted construction practice.
- B. **Storage:**
  - 1. Store products to allow for inspection and measurement of quantity or counting of units.
  - 2. Store materials in a manner that will not endanger Project structure.

3. Store products that are subject to damage by the elements, under cover in a weathertight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Provide a secure location and enclosure at Project site for storage of materials and equipment by Owner's construction forces. Coordinate location with Owner.

**1.13 PRODUCT WARRANTIES**

- A. Refer to Division 01 and individual sections for requirements.
- B. The following requirements are supplemental and in addition to those stated in other specific sections and Division 01.
  1. Warranty all materials and workmanship under these Specifications and the Contract for a period of one year from the date of final acceptance by the Owner.
  2. During this warranty period, correct or replace all defects developing through materials or workmanship immediately as directed by the Engineer without expense to the Owner; make all such repairs or replacements to the Owner's satisfaction.
- C. Warranties specified in other Sections shall be in addition to, and run concurrent with, other warranties required by the Contract Documents. Manufacturer's disclaimers and limitations on product warranties do not relieve Contractor of obligations under requirements of the Contract Documents.
- D. Warranty Start Date: From the date of final acceptance by the Owner.

**1.14 SUBMITTAL PROCEDURES**

- A. Comparable Product: Product that is demonstrated and approved through submittal process to have the indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.
- B. Product List: Submit a list, in tabular form, showing specified products. Include generic names of products required. Include manufacturer's name and proprietary product names for each product.
  1. Initial Submittal: Within 30 days after date of commencement of the Work, submit 3 copies of initial product list. Include a written explanation for omissions of data and for variations from Contract requirements.
- C. Substitution Requests: Submit four copies of each request for consideration. Identify product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
  1. Substitution: A submittal shall be considered a substitution when the Engineer/Architect does not accept the product or material as an "equivalent" or where one of the listed manufacturers is not submitted.
  2. Substitution Requirements: Substitutions shall meet the requirements of "Comparable Products."
  3. Documentation: Show compliance with requirements for substitutions and the following, as applicable:
    - a. Statement indicating why specified material or product cannot be provided.
    - b. Coordination information, including a list of changes or modifications needed to other parts of the Work and to construction performed by Owner and separate contractors, that will be necessary to accommodate proposed substitution.

- c. Detailed comparison of significant qualities of proposed substitution with those of the Project scope of work specified. Significant qualities may include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
- d. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
- e. Samples, where applicable or requested.
- f. Cost information, including a proposal of change, if any, in the Contract Sum.
- g. Contractor's certification that proposed substitution complies with requirements in the Contract Documents and is appropriate for applications indicated.
- h. Contractor's waiver of rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- i. Statement indicating why the requested substitution offers Owner a substantial advantage in cost, time, energy conservation, or other considerations.

**1.15 RECORD DRAWINGS AND RECORD DIGITAL FILES**

A. Record Drawings and Record Digital Files: Comply with the following:

1. Submit Record Drawings and Record Digital Files as follows:

- a. Initial Submittal: Submit one set of plots from corrected Record CAD Drawings and one set of marked-up Record Prints. Engineer will initial and date each plot and mark whether general scope of changes, additional information recorded, and quality of drafting are acceptable. Engineer will return plot for organizing into sets, printing, binding, and final submittal.
- b. Final Submittal: Submit one set of marked-up Record Prints.
- c. Final Submittal: Submit three sets of Record CAD Drawing files and one set of Record CAD Drawing plots. Plot and print each drawing, whether or not changes and additional information were recorded.

1) Electronic Media: CD-R.

B. Qualification Data: For training instructor.

**1.16 PRODUCT SELECTION PROCEDURES**

A. General Product Requirements: Provide products that comply with the Contract Documents, that are undamaged and, unless otherwise indicated, that are new at time of installation.

- 1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
- 2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types that have been produced and used successfully in similar situations on other projects.
- 3. Owner reserves the right to limit selection to products with warranties not in conflict with requirements of the Contract Documents.
- 4. Where products are accompanied by the term "as selected," Engineer and/or Architect will make selection.
- 5. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.
- 6. Or Equal: Where products are specified by name and accompanied by the term "or equal" or "or approved equal" or "or approved," comply with provisions in "Comparable Products" Article to obtain approval for use of an unnamed product.

B. Product Selection Procedures:

- 1. Design Basis: The design has been based on the single manufacturer indicated in the contract documents. The Contractor is responsible for verifying prior to submission, that any other manufacturer even though listed complies with dimensional and performance characteristics of the

base specified product. Modifications shall be made by the Contractor as part of this contract to accommodate changes to the design basis.

2. Product: Where Specifications name a single product and manufacturer, provide the named product that complies with requirements.
3. Manufacturers: Where Specifications include a list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements.
4. Equivalent Product: Equipment, material or devices submitted for review as an "accepted equivalent" shall meet all of the following requirements:
  - a. A product of a listed manufacturer.
  - b. The equivalent shall have the same construction features such as, but not limited to:
    - 1) Material thickness, gauge, weight, density, etc.
    - 2) Welded, riveted, bolted, etc., construction
    - 3) Finish, undercoating, corrosion protection
  - c. The equivalent shall perform with the same or better operating efficiency.
  - d. The equivalent shall have equal or greater reserve capacity.
  - e. The equivalent shall be locally represented by the manufacturer for service, parts and technical information.
  - f. The equivalent shall bear the same labels of performance certification as is applicable to the specified item, such as UL, AMCA or ARI labels.

#### **1.17 PRODUCT INTEROPERABILITY REQUIREMENTS**

- A. Interoperability Coordination Meeting: Attend a minimum of 3 weekly coordination meetings to coordinate interoperability between all systems and equipment. Meetings shall be scheduled by the construction manager.
- B. General Networking and Protocol Interoperability Requirements: Provide products that are fully BACNet interoperable.
  1. All systems and equipment shall interface with the primary building management network provided under "Instrumentation and Controls for HVAC" using Ethernet standards and BACNet protocol.
  2. Equipment that is native BACNet may connect directly to a BACNet MS/TP subnet that is provided by "Instrumentation and Controls for HVAC" when coordinated with that Section Contractor.
  3. Communication involving control components (i.e., all types of controllers and operator interfaces) shall conform to the most current ANSI/ASHRAE Standard 135, BACnet.
  4. The MS/TP trunks support all of the ASHRAE 135 approved baud rates.
  5. All MS/TP devices support all baud rates of the ASHRAE 135.
  6. All MS/TP devices shall be BTL approved ( BACnet Testing Lab).
  7. All BACnet routers must support B-BC (BIBB) and support BBMD routing.
  8. Lonworks and Modbus subnets may be utilized where no BACNet protocol is available provided full 2-way compatibility is provided through a gateway.
    - a. Exception: Fire alarm systems shall be 1-way, read only communication.
  9. Each individual system and/or equipment manufacturer/installer shall provide all necessary gateways/translators Provide Gateway with all products as required facilitating full BACNet interoperability with BACNet Protocol.
  10. It must be possible to read and display the value of any property, including all required properties, supported optional properties, and proprietary extensions of very object of every networked device.
  11. Operating setpoints and parameters must be available for modification via BACnet services via a graphical user interface (GUI).
  12. An operator shall be able to display at any time the operational status of any device on the BACnet internetwork. An operator shall be able to display at any time any property of any BACnet object. An operator shall also be able to display property values of objects grouped by object type, object location, building system, and by user defined parameters.
  13. An operator shall have the ability to issue re-initialization commands to any device that supports remote re-initialization.

14. An operator shall have the ability to backup and restore all BACnet devices on the network.
  15. It shall be each contractor's responsibility to configure each router using the network numbering scheme for the project. Each router shall be configured such that all network layer error messages shall be directed to a specific workstation using the BACnet Confirmed Text Message service. It shall be the contractor's responsibility to initially configure each router with routing tables containing all network numbers that are part of the project's internet. The router shall be able to receive messages at each port of any length that is valid for the LAN technology connected to that port, and to forward the message to any directly-connected network that can convey a message of that size.
  16. Legacy Systems: Bi-directional gateways shall be provided for systems and equipment operating on a legacy/proprietary system. The operator workstation shall display information from both the BACnet and non-BACnet devices. Any information specified or required for system functionality shall be made readable and modifiable. Gateways shall have 10% expansion capacity. Gateways shall support archiving, uploading, trending, scheduling, and alarm/event detection, notification and acknowledgement.
  17. Systems and equipment shall have full 2- way communications and interoperability.
    - a. Exception: Fire safety systems and equipment shall have only read access to outside systems:
      - 1) Fire alarm.
  18. Coordinate with "Instrumentation and Controls for HVAC" and other building operational systems for specific interoperability requirements.
- C. Communications Standard: Coordinate communications standards requirements with other Sections and Divisions.
1. MS/TP LAN: RS 485
  2. Systems with dedicated network(s) shall connect on the BACNet Ethernet LAN: utilizing a switch and shall meet standard Ethernet requirements.
    - a. Utilize RJ-45 terminations.
    - b. Utilize CAT 6 cabling.
    - c. Meet IEEE Standard 802.3 standards and requirements.
    - d. Speed: 100 Mbps.
  3. Equipment without dedicated networks shall connect to the BACNet MS/TP LAN.
    - a. RS 485 communications standard.
    - b. Speed: 1 Mbps.
- D. Information Availability: Make all product information, points, variables, setpoints, etc., available for access of building operational systems upon request.
1. Provide bi-directional point mapping/addressing instructions.
  2. Provide on-site technicians as required to ensure proper information exchange.
- E. Factory Provided Equipment Controllers: Provide all information, points, variables, setpoints, etc., indicated and referenced in all documentation, including "Instrumentation and Controls for HVAC." Products shall have full interoperability as indicated in this Section, in BACNet standards and elsewhere.

## **PART 2 - PRODUCTS**

### **2.1 SHOP DRAWINGS**

- A. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed or electronic data.

1. Preparation: Fully illustrate requirements in the Contract Documents. Include the following information, as applicable:
  - a. Identification of products.
  - b. Schedules.
  - c. Compliance with specified standards.
  - d. Notation of coordination requirements.
  - e. Notation of dimensions established by field measurement.
  - f. Relationship and attachment to adjoining construction clearly indicated.
  - g. Seal and signature of professional engineer if specified.
2. Sheet Size: Except for templates, patterns, and similar full-size drawings, submit Shop Drawings on sheets at least 8-1/2 by 11 inches but no larger than 30 by 42 inches.

## **2.2 RECORD DRAWINGS**

- A. Record Prints: Maintain one set of black-line white prints of the Contract Drawings and Shop Drawings.
  1. Preparation: Mark Record Prints to show the actual installation where installation varies from that shown originally. Require individual or entity who obtained record data, whether individual or entity is Installer, subcontractor, or similar entity, to prepare the marked-up Record Prints.
    - a. Give particular attention to information on concealed elements that would be difficult to identify or measure and record later.
    - b. Accurately record information in an understandable drawing technique.
    - c. Record data as soon as possible after obtaining it. Record and check the markup before enclosing concealed installations.
  2. Content: Types of items requiring marking include, but are not limited to, the following:
    - a. Revisions to details shown on Drawings.
    - b. Locations and depths of underground system entities.
    - c. Revisions to routing of piping.
    - d. Actual equipment locations.
    - e. Duct size and routing.
    - f. Locations of concealed internal utilities.
    - g. Changes made by Change Order or Change Directive.
    - h. Changes made following Engineer's written orders.
    - i. Details not on the original Contract Drawings.
    - j. Field records for variable and concealed conditions.
    - k. Record information on the Project scope of work that is shown only schematically.
  3. Mark the Contract Drawings or Shop Drawings, whichever is most capable of showing actual physical conditions, completely and accurately. If Shop Drawings are marked, show cross-reference on the Contract Drawings.
  4. Mark record sets with erasable, colored pencil. Use multiple colors to distinguish between changes for different categories of the Work at same location.
  5. Mark important additional information that was either shown schematically or omitted from original Drawings.
  6. Note Construction Change Directive numbers, alternate numbers, Change Order numbers, and similar identification, where applicable.
- B. Record CAD Drawings: Immediately before observation for Certificate of Substantial Completion, review marked-up Record Prints with Engineer and Construction Manager. When authorized, prepare a full set of corrected CAD Drawings of the Contract Drawings, as follows:
  1. Format: DWG or Revit format of the same version, and operating system as the original Contract Drawings.
  2. Incorporate changes and additional information previously marked on Record Prints. Delete, redraw, and add details and notations where applicable.



3. Refer instances of uncertainty to Engineer for resolution.
4. Contractor may request one set of CAD Drawings of the Contract Drawings for use in recording information.
  - a. Engineer makes no representations as to the accuracy or completeness of CAD Drawings as they relate to the Contract Drawings.
- C. Format: Identify and date each Record Drawing; include the designation "PROJECT RECORD DRAWING" in a prominent location.
  1. Record Prints: Organize Record Prints and newly prepared Record Drawings into manageable sets. Bind each set with durable paper cover sheets. Include identification on cover sheets.
  2. Record CAD/Revit Drawings: Organize information into separate electronic files that correspond to each sheet of the Contract Drawings. Name each file with the sheet identification. Include identification in each file.
  3. Identification: As follows:
    - a. Project name.
    - b. Date.
    - c. Designation "PROJECT RECORD DRAWINGS."
    - d. Name of Engineer, Architect and Construction Manager.
    - e. Name of Contractor.

### **2.3 RECORDING AND MAINTENANCE**

- A. Recording: Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur; do not wait until the end of Project.
- B. Maintenance of Record Documents and Samples: Store Record Documents and Samples in the field office apart from the Contract Documents used for construction. Do not use Project Record Documents for construction purposes. Maintain Record Documents in good order and in a clean, dry, legible condition, protected from deterioration and loss. Provide access to Project Record Documents for Engineer's reference during normal working hours.

### **2.4 TRAINING AND INSTRUCTION PROGRAM**

- A. Program Structure: In addition to Division 01 and individual section requirements, develop an instruction program that includes individual training modules for each system and equipment not part of a system.
- B. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. Provide instruction for the following modules.
  1. Basis of System Design and Operational Requirements
  2. Documentation
  3. Emergencies
  4. Adjustments
  5. Troubleshooting
  6. Maintenance
  7. Repairs
- C. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

## 2.5 COMPARABLE PRODUCTS

- A. Conditions for Consideration: Engineer/Architect will consider Contractor's request for comparable product when the following conditions are satisfied. If the following conditions are not satisfied, Engineer/Architect may return requests without action, except to record noncompliance with these requirements:
1. Evidence that the proposed product does not require revisions to the Contract Documents, that it is consistent with the Contract Documents and will produce the indicated results, and that it is compatible with other portions of the Work.
  2. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
  3. Evidence that proposed product provides specified warranty.
  4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
  5. Samples, if requested.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning work, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utility and system connections.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
  3. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Acceptance of Conditions: Examine substrates, areas, and conditions, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
1. Written Report: Where a written report listing conditions detrimental to performance of the Project scope of work is required by other Sections, include the following:
    - a. Description of the Work.
    - b. List of detrimental conditions, including substrates.
    - c. List of unacceptable installation tolerances.
    - d. Recommended corrections.
  2. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
  3. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  4. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  5. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

**3.2 PREPARATION**

- A. Existing Utility Information: Furnish information to local utility and Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
- B. Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Review of Contract Documents and Field Conditions: Immediately on discovery of the need for clarification of the Contract Documents, submit a request for information to Engineer. Include a detailed description of problem encountered, together with recommendations for changing the Contract Documents.

**3.3 DEMOLITION**

- A. Work indicated to be removed includes removal of all auxiliary materials, accessories, anchorage, fasteners, and etc., down to bare substrate. No residual materials shall remain from work to be removed. Contractor will use whatever means necessary; including removal of all materials attached or related to those items designated to be removed, as acceptable to Owner and Engineer, to provided complete and thorough removal of existing work.
- B. Protect existing equipment and installations indicated to remain. If damaged or disturbed in the course of the Work, remove damaged portions and install new products of equal capacity, quality, and functionality.
- C. Accessible Work: Remove exposed equipment and installations, indicated to be demolished, in their entirety.
- D. Abandoned Work: Cut and remove buried MEP system materials, equipment, raceways, piping and distribution, indicated to be abandoned in place, 2 inches below the surface of adjacent construction. Cap and patch surface to match existing finish.
- E. Remove demolished materials from Project site.
- F. Remove, store, clean, reinstall, reconnect, and make operational components indicated for relocation.
- G. Field verify all existing MEP system materials, equipment, raceways, piping and distribution to be removed for exact quantities.
- H. Remove all existing MEP system materials, equipment, raceways, piping and distribution located above ceilings and in walls that are not being reused.
- I. Remove all MEP systems and appurtenances, which are to be removed, in their entireties back to the source or source panels.
- J. Remove all existing MEP system materials, equipment, raceways, piping and distribution located in walls or ceilings being demolished. Abandon no devices that have been disconnected unless specifically noted.
- K. Maintain continuity of all existing MEP devices, and utilization equipment not removed.
- L. Remove, store, protect, and reinstall existing work as required to accommodate alteration indicated.

- M. The existing work to be removed, in general, is as indicated on the Drawings and in this Section, but also includes any materials or work necessary to permit installation of new materials, as approved by Owner and Engineer.
  
- N. Disconnect, demolish, and remove systems, equipment, and components indicated to be removed, abandoned or as made obsolete by this project.
  - 1. To Be Removed: Remove portion of systems, equipment, and components indicated to be removed and cap or plug remaining with same or compatible material.
  - 2. To Be Abandoned in Place: Drain piping and cap or plug systems, equipment, and components with same or compatible material.
  - 3. Equipment to Be Removed: Disconnect, make safe and cap services and remove equipment.
  - 4. Equipment to Be Removed and Reinstalled: Disconnect, make safe and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational.
  - 5. Equipment to Be Removed and Salvaged: Disconnect, make safe and cap services and remove equipment and deliver at direction of Owner.
  
- O. If systems, equipment, and components to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.
  
- P. In finished areas, all systems, equipment, and components shall be cut back to a concealed location, i.e., within walls, above ceilings, etc., before capping.

### **3.4 INSTALLATION**

- A. General: Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  - 1. Make vertical work plumb and make horizontal work level.
  - 2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  - 3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.
  - 4. Maintain minimum headroom clearance as indicated by Architect and/or Construction Manager in spaces without a suspended ceiling.
  
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
  
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
  
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
  
- E. Tools and Equipment: Do not use tools or equipment that produces harmful noise levels.
  
- F. Templates: Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
  
- G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of the Work.
  - 1. All electrical equipment and piping not supported from the building structural steel shall not exceed a combined load of 7 psf when supported from the metal deck/slab. Any condition that may exceed this limit shall be reviewed and approved by the Design-Builder and Structure Engineer before installation.

2. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Engineer and/or to allow for proper access.
  3. Allow for building movement, including thermal expansion and contraction.
  4. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- H. Hazardous Materials: Use products, cleaners, and installation materials that are not considered hazardous.

### **3.5 CUTTING AND PATCHING**

- A. See Division 01 for additional requirements. The Contractor shall furnish sketches showing the location and sizes of all openings, chases, etc., required for the installation of Work.
- B. Work under this Division shall include furnishing, locating and setting inserts and/or sleeves required before the walls are built or be responsible for cutting, drilling or chopping where sleeves and inserts were not installed, where wall or floors are existing or not correctly located. The Contractor shall do all drilling required for the installation of hangers.
- C. Exercise extreme caution when core drilling or punching openings in concrete floor slabs in order to avoid cutting or damaging structural members. No structural members or structural slabs/floors shall be cut without the written acceptance of the Structural Engineer and all such cutting shall be done in a manner directed by him.
- D. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials from adjacent finished surfaces.

### **3.6 SCAFFOLDING, RIGGING, HOISTING**

- A. The Contractor shall furnish all scaffolding, rigging, hoisting and services necessary for erection and delivery into the premises any equipment and apparatus furnished under this Division. Remove same from premises when no longer required.

### **3.7 EXCAVATION AND BACKFILLING**

- A. It is the responsibility of the Contractor to coordinate sizes, depths, fill and bedding requirements and any other excavation work required under this Division.

### **3.8 ACCESSIBILITY AND ACCESS PANELS**

- A. The Contractor shall be responsible for the adequate thickness of partitions, and the adequate clearance in double partitions and hung ceilings for the proper installation of the Work.
- B. Locate all equipment which must be serviced, operated or maintained in fully accessible positions. Equipment shall include, but not be limited to: motors, controllers, coil, valves, switchgear, drain points, etc. Access doors shall be furnished if required for better accessibility. Minor deviations from the Drawings may be made to allow better accessibility, but changes of magnitude or which involve extra cost shall not be made without the acceptance of the Engineer.
- C. Access doors in walls, ceilings, etc., shall be field coordinated. It is the responsibility of the Contractor to coordinate and provide information regarding the sizes and quantities of access doors required for his work. The Contractor shall arrange his work in such a manner as to minimize the quantity of access doors required, such as grouping shutoff valves in the same area. Where possible, locate valves in already accessible areas, such as lay-in ceilings, etc.

- D. On a clean set of prints, the Contractor shall mark in red pencil the location of each required access door, including its size and fire rating (if any), and shall submit the print to the Architect for review before access doors are purchased or installed.
- E. Upon completion of the Project, the Contractor shall physically demonstrate that all equipment and devices installed have been located and/or provided with adequate access panels for repair, maintenance and/or operation. Any equipment not so furnished shall be relocated or provided with additional access panels by the installing Contractor at no additional cost to the Owner.

**3.9 STARTING AND ADJUSTING**

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Manufacturer's Field Service: Provide a factory-authorized service representative to inspect field-assembled components and equipment installation, comply with qualification requirements in "Quality Requirements."

**3.10 PROTECTION OF INSTALLED CONSTRUCTION**

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.
- C. Remove debris from concealed spaces before enclosing the space.
- D. Remove liquid spills promptly.
- E. Where dust would impair proper execution of the Project scope of work, broom-clean or vacuum the entire work area, as appropriate.
- F. Installed Work: Keep installed work clean.
- G. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.
- H. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- I. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- J. Limiting Exposures: Supervise construction operations to assure that no part of the construction completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.

**3.11 CORRECTION OF THE WORK**

- A. The cost of corrective work shall be included under the contract.

- B. Repair or remove and replace defective construction.
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- C. Restore permanent facilities used during construction to their specified or original condition.
- D. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- E. Repair components that do not operate properly. Remove and replace operating components to new condition.
- F. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

**END OF SECTION 28 00 10**  
07/10/2018

**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. Fire alarm wire and cable.
  - 2. Identification products.

**1.3 DEFINITIONS**

- A. EMI: Electromagnetic interference.
- B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

**1.4 SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.
- C. Maintenance Data: For wire and cable to include in maintenance manuals.

**1.5 QUALITY ASSURANCE**

- 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 application.

**1.6 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

**PART 2 - PRODUCTS**

**2.1 PATHWAYS**

- A. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."
  - 1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

**2.2 FIRE ALARM WIRE AND CABLE**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Comtran Corporation.
  - 2. Draka Cableteq USA.
  - 3. Genesis Cable Products; Honeywell International, Inc.
  - 4. Rockbestos-Suprenant Cable Corp.



5. West Penn Wire; a brand of Belden Inc.
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer to the following criteria. Ampacity of 75 cd strobe wherever a strobe intensity is not indicated on plans, plus ampacity of strobe wherever the strobe intensity is indicated as larger than 75 cd, plus 25 percent spare capacity to allow for future devices or infield adjustments.
  1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.
  1. Low-Voltage Circuits: No. 16 AWG, minimum.
  2. Line-Voltage Circuits: No. 12 AWG, minimum.
  3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

### **2.3 IDENTIFICATION PRODUCTS**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  1. Brady Corporation.
  2. HellermannTyton.
  3. Kroy LLC.
  4. PANDUIT CORP.
- B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

## **PART 3 - EXECUTION**

### **3.1 INSTALLATION OF PATHWAYS**

- A. Comply with TIA-569-B for pull-box sizing and length of conduit and number of bends between pull points.
- B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.
- C. Install manufactured conduit sweeps and long-radius elbows whenever possible.
- D. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

### **3.2 FIRE ALARM WIRING INSTALLATION**

- A. Comply with NECA 1 and NFPA 72.
- B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.
- C. Wiring Method:
1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
  2. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.
- D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.
- G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.
- H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

### **3.3 CONTROL-CIRCUIT CONDUCTORS**

- A. Minimum Conductor Sizes:
1. Class 1 remote-control and signal circuits, No. 14 AWG.
  2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
  3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

### **3.4 CONNECTIONS**

- A. Comply with requirements in Division 28 Section "Fire Detection and Alarm" for connecting, terminating, and identifying wires and cables.

### **3.5 FIRESTOPPING**

- A. Comply with requirements in Division 07 Section "Penetration Firestopping."

### **3.6 IDENTIFICATION**

- A. Identify system components, wiring, and cabling. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

### **3.7 FIELD QUALITY CONTROL**

- A. Testing Agency: Engage a factory-authorized service representative.

- B. End-to-end cabling will be considered defective if it does not pass tests and inspections.

**END OF SECTION 28 05 14**  
07/10/2018

**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. Fire-alarm control unit.
  - 2. Manual fire-alarm boxes.
  - 3. System smoke detectors.
  - 4. Heat detectors.
  - 5. Notification appliances.
  - 6. Addressable interface device.

**1.3 DEFINITIONS**

- A. LED: Light-emitting diode.
- B. NICET: National Institute for Certification in Engineering Technologies.

**1.4 SYSTEM DESCRIPTION**

- A. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.
  - 1. Interface with existing fire alarm system.

**1.5 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For fire-alarm system. Include plans, elevations, sections, details, and attachments to other work.
  - 1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.
  - 2. Include voltage drop calculations for notification appliance circuits.
  - 3. Include battery-size calculations.
  - 4. Locate detectors according to manufacturer's written recommendations.
  - 5. Ductwork Coordination Drawings: Plans, sections, and elevations of ducts, drawn to scale and coordinating the installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, the detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.
  - 6. System riser diagram with all device types and cable and wire types and sizes.
  - 7. Wiring Diagrams: Power, signal and control wiring. Include diagrams for equipment and for system with all terminals and interconnections identified. Show wiring color code.
- C. General Submittal Requirements:
  - 1. Shop Drawings shall be prepared by persons with the following qualifications:
    - a. Trained and certified by manufacturer in fire-alarm system design.
    - b. NICET-certified fire-alarm technician, Level III minimum.

**1.6 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified Installer.
- B. Seismic Qualification Certificates: For fire-alarm control unit, 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.
  - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Field quality-control reports.

**1.7 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
  - 2. Smoke Detectors, Fire Detectors, and Addressable Interface Devices: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
  - 3. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
  - 4. Audible and Visual Notification Appliances: Three of each type installed.
  - 5. Fuses: Two of each type installed in the system.

**1.8 QUALITY ASSURANCE**

- A. Installer Qualifications: Personnel licenses by the City and/or State.
- 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 application.
- C. Manufacturer Qualifications: Source must be an authorized distributor of the specified manufacturer and authorized to sell in project area.

**1.9 PROJECT CONDITIONS**

- A. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service according to requirements indicated:
  - 1. Notify Architect, Construction Manager and Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
  - 2. Do not proceed with interruption of fire-alarm service without Architect's, Construction Manager's and Owner's written permission.

**1.10 SEQUENCING AND SCHEDULING**

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational.

**1.11 ADDITIONAL SCOPE TO BE INCLUDED IN BASE CONTRACT**

- A. Furnish, install, wire (with 50 ft. of approved wiring and conduit), terminate and program the following in addition to those indicated on the drawings or implied in the control sequence:
  - 1. Smoke Detector with Base: Quantity equal to 5 percent of units installed, but not less than two units.
  - 2. Combination Audio/Visual Notification Appliance: Quantity equal to 5 percent of units installed, but not less than five units.
  - 3. Visual Notification Appliance: Quantity equal to 5 percent of units installed, but not less than ten units.
  - 4. Manual Fire Alarm Box: Quantity equal to 5 percent of units installed, but not less than two units.
  - 5. Addressable Interface Devices: Quantity equal to 5 percent of units installed, but not less than ten units.
  - 6. Speaker: Quantity equal to 5 percent of units installed, but not less than ten units.
  
- B. If units are not utilized before substantial completion of Project, then at the Owner's option, either turn units over to Owner or provide credit to Owner for deletion of material and labor.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

- A. Basis-of-Design Product: Subject to compliance with requirements, provide NOTIFIER; a Honeywell company; NFS320.

**2.2 SYSTEMS OPERATIONAL DESCRIPTION**

- A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:
  - 1. Manual stations.
  - 2. Heat detectors.
  - 3. Smoke detectors.
  - 4. Duct smoke detectors.
  - 5. Verified automatic alarm operation of smoke detectors.
  - 6. Heat detectors in elevator shaft and pit.
  
- B. Fire-alarm signal shall initiate the following actions:
  - 1. Continuously operate alarm notification appliances.
  - 2. Identify alarm at fire-alarm control unit and remote annunciators.
  - 3. Transmit an alarm signal to the remote alarm receiving station.
  - 4. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
  - 5. Close smoke dampers in air ducts/HVAC units of designated air-conditioning duct systems serving zone where alarm was initiated.
  - 6. Activate emergency shutoffs for gas, fuel and power supplies for equipment under kitchen hoods. Provide additional contactors and relays and pushbuttons to control and monitor hoods, valves, makeup fans and equipment.
  - 7. Record events in the system memory.
  
- C. System trouble signal initiation shall be by one or more of the following devices and actions:
  - 1. Open circuits, shorts, and grounds in designated circuits.
  - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
  - 3. Loss of primary power at fire-alarm control unit.
  - 4. Ground or a single break in fire-alarm control unit internal circuits.
  - 5. Abnormal ac voltage at fire-alarm control unit.
  - 6. Break in standby battery circuitry.
  - 7. Failure of battery charging.
  - 8. Abnormal position of any switch at fire-alarm control unit or annunciator.

- D. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit and remote annunciators.

**2.3 FIRE-ALARM CONTROL UNIT**

- A. General Requirements for Fire-Alarm Control Unit:

- 1. Existing fire alarm Notifier NFS320.

**2.4 MANUAL FIRE-ALARM BOXES**

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

- 1. Single-action mechanism, breaking-glass or plastic-rod type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
  - 2. Station Reset: Key-operated switch.
  - 3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation.
  - 4. Weatherproof Protective Shield: Provide where appropriate. Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm.

**2.5 SYSTEM SMOKE DETECTORS**

- A. General Requirements for System Smoke Detectors:

- 1. Comply with UL 268; operating at 24-V dc, nominal.
  - 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
  - 3. Provide combination of smoke detector with carbon monoxide detector wherever indicated on electrical plans. Carbon monoxide detectors shall be connected to the building fire alarm system control panel.
  - 4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
  - 5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status. Provide remote status and alarm indicator and test station where noted or indicated.
  - 6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.
    - a. Provide multiple levels of detection sensitivity for each sensor.

- B. Photoelectric Smoke Detectors:

- 1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
  - 2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
    - a. Primary status.
    - b. Device type.
    - c. Present average value.
    - d. Present sensitivity selected.
    - e. Sensor range (normal, dirty, etc.).

3. Multipurpose type, containing the following:
  - a. Integral Addressable Module: Arrange to communicate detector status (normal, alarm, or trouble) to the FACP.
  - b. Piezoelectric sounder rated at 88 dBA at 10 ft. according to UL 464.
  - c. Heat sensor, combination rate of rise and fixed temperature.

C. Duct Smoke Detectors: Photoelectric type complying with UL 268A.

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
  - a. Primary status.
  - b. Device type.
  - c. Present average value.
  - d. Present sensitivity selected.
  - e. Sensor range (normal, dirty, etc.).
3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Low Velocity Detectors: Design as recommended by manufacturer for the specific air velocity and installation conditions where applied.
7. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit or smoke damper control.

## 2.6 HEAT DETECTORS

- A. General Requirements for Heat Detectors: Comply with UL 521.
- B. Provide combination of heat detector with carbon monoxide detector whenever indicated on electrical plans. Carbon monoxide detectors shall be connected to the building fire alarm control panel.
- C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or a rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
  1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
  2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
  1. Mounting: Adapter plate for outlet box mounting or twist-lock base interchangeable with smoke-detector bases depending on location.
  2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

## 2.7 NOTIFICATION APPLIANCES

- A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as indicated, equipped for mounting as indicated and with screw terminals for system connections. Color to be selected by Architect; on renovation projects, match color of existing devices.
  1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.



- B. Horns: Piezoelectric sounder, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 87 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol. Units shall be capable of producing various selectable tones and sounds.
- C. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch-high letters on the lens.
  - 1. Rated Light Output:
    - a. 15/30/75 field adjustable cd (batteries based upon 75 cd).
    - b. 110/135/177 cd, field adjustable.
  - 2. Mounting: Wall mounted unless otherwise indicated.
  - 3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.
  - 4. Flashing shall be in a temporal pattern, synchronized with other units whenever more than two units are visible in any space.
  - 5. Strobe Leads: Factory connected to screw terminals.

**2.8 ADDRESSABLE INTERFACE DEVICE**

- A. Description: Microelectronic monitor module, NRTL listed for use in providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- B. Integral Relay: Capable of providing a direct signal to elevator controller, motor controllers, dampers, circuit-breaker shunt trip, or other devices.

**PART 3 - EXECUTION**

**3.1 EQUIPMENT INSTALLATION**

- A. Comply with NFPA 72 for installation of fire-alarm equipment.
- B. Connecting to Existing Equipment: Verify that existing fire-alarm is operational before making changes or connections.
  - 1. Connect new equipment to existing control panel in existing part of building.
  - 2. Connect new equipment to existing monitoring equipment at supervising station.
  - 3. Expand, modify, and supplement existing control and monitoring equipment as necessary to extend existing control and monitoring functions to new points. New components shall be capable of merging with existing configuration without degrading the performance of either system.
  - 4. Coordinate connections to existing fire alarm control panel and scheduling of panel upgrade with owner.
  - 5. Reprogram existing fire alarm control panel and existing annunciator panels as required.
- C. Smoke- or Heat-Detector Spacing:
  - 1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.
  - 2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.
  - 3. Smooth ceiling spacing shall not exceed 30 feet.
  - 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix A or Appendix B in NFPA 72.
  - 5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.
  - 6. Luminaires: Locate detectors not closer than 12 inches from any part of a luminaire.

- D. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Install remote test switch and indicating light in location as directed in field. Coordinate installation with Division 23. Provide a permanent placard to clearly identify location of detector per NFPA 72. Provide one low velocity detector per each 36-inch width of transfer ducts. Locate test switch in same space as smoke detector.
- E. Transfer Duct and Plenum In-Duct Smoke Detectors: Comply with NFPA 72. Provide low velocity in-duct smoke detectors within transfer ducts and duct plenums. For transfer ducts up to 36 inches in width, provide one detector. For ducts up to 72 inches in width, provide two detectors at quarter points of the duct. For ducts greater than 72 inches in width, provide detectors 24 inches on center. Provide a permanent placard to clearly identify location of detector per NFPA 72. Provide one low velocity detector per each 36 inches in width of transfer ducts. Locate test switch in same space as smoke damper.
- F. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling or 80 inches above finished floor, whichever is lower. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille.
- G. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install bottom of strobe not less than 6 inches below the ceiling or 80 inches above finished floor, whichever is lower.
- H. Device Location-Indicating Lights: Locate in public space near the device they monitor.
- I. Manual Fire-Alarm Boxes: Install top of box at 48 inches above finished floor.
- J. Program the system utilizing final room names and numbers as provided by Architect and Owner, which may be different from information shown on the Bid Documents.
- K. The detectors shall be connected as a separate zone or zones to the fire alarm signaling system, but shall only activate a supervisory signal at the main control unit and any remote annunciators. The CO detection shall not activate the building evacuation alarm.
- L. Any room containing fuel-burning heating equipment and CO detection shall be provided with a sign at all entrances to the space indicating that CO detectors are located inside the space.

### **3.2 CONNECTIONS**

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
  - 1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
  - 1. Smoke dampers in air ducts of designated air-conditioning duct systems.
  - 2. Smoke dampers in elevator shafts.
  - 3. Heating, ventilating and air conditioning designated equipment controls.
  - 4. Alarm-initiating connection to elevator recall system and components.
  - 5. Alarm-initiating connection to activate fire extinguishing system operation.
  - 6. Provide appropriate UL relays and auxiliary contacts to interface with mechanical equipment locally.
  - 7. Provide control and monitoring of hood systems, makeup air systems, equipment under hoods, gas valves and emergency shutoffs.
  - 8. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.

- C. Coordinate all features of fire alarm devices with HVAC systems, including interface with HVAC control systems, power and control wiring requirements. See Section 233300 "Air Duct Accessories" and HVAC control sections for requirements and sequence of operations.

### **3.3 IDENTIFICATION**

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.
- C. Paint power-supply disconnect switch red and label "FIRE ALARM."

### **3.4 GROUNDING**

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100.

### **3.5 FIELD QUALITY CONTROL**

- A. Field tests shall be witnessed by Architect/Engineer and authorities having jurisdiction. Proper planning and scheduling (five days) is required.
- B. Perform tests and inspections.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Provide additional factory-authorized technician site visits and field programming during field testing and twice for post occupancy programming adjustments and testing for Owner-initiated changes and tailoring to actual conditions during the first six months.
- D. Tests and Inspections:
  - 1. Visual Inspection: Conduct visual inspection prior to testing.
    - a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.
    - b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
  - 2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
  - 3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.
- J. Test and Inspection Records: Prepare according to NFPA 72, including demonstration of sequences of operation by using the matrix-style form in Appendix A in NFPA 70.
- K. Provide two site visits for post occupancy follow-up programming to fine tune sensitive, audio, visual, and any follow-up programming required within first year.

**3.6 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. As a minimum and in addition to the requirements of other sections, provide two (2) 8-hour days of owner training sessions in addition to multiple start-up visits to properly support the contractor.

**END OF SECTION 28 31 11**  
07/10/2018

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**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. State of Connecticut Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form 817.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Protecting existing vegetation to remain.
  - 2. Removing existing vegetation.
  - 3. Clearing and grubbing.
  - 4. Stripping and stockpiling topsoil.
  - 5. Removing above- and below-grade site improvements.
  - 6. Disconnecting, capping or sealing, removing site utilities and abandoning site utilities in place.

**1.3 DEFINITIONS**

- A. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- B. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically 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 and is the zone where plant roots grow.
- D. Topsoil: Top layer of the soil profile consisting of existing native surface topsoil or existing in-place surface soil and is 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 more than 2 inches in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.
- 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 defined by a circle concentric with each tree with a radius 1.5 times the diameter of the drip line unless otherwise indicated.
- G. Vegetation: Trees, shrubs, groundcovers, grass, and other plants.

**1.4 MATERIAL OWNERSHIP**

- A. Except for stripped topsoil and other 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.

**1.5 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 videotape.
  2. Include plans and notations to indicate specific wounds and damage conditions of each tree or other plants designated to remain.
- B. Record Drawings: Identifying and accurately showing locations of capped utilities and other subsurface structural, electrical, and mechanical conditions.

## 1.6 QUALITY ASSURANCE

- A. Preinstallation Conference: Conduct conference at Project site.

## 1.7 PROJECT 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 traffic ways 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. Salvable 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. 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.
- I. Soil Stripping, Handling, and Stockpiling: Perform only when the topsoil is dry or slightly moist.

## PART 2 - PRODUCTS

### 2.1 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.

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**PART 3 - EXECUTION**

**3.1 PREPARATION**

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated. Wrap a 1-inch blue vinyl tie tape flag around each tree trunk at 54 inches above the ground.
- 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. 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 specifications.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

**3.3 TREE AND PLANT PROTECTION**

- A. General: Protect trees and plants remaining on-site according to requirements in Section 015639 "Temporary Tree and Plant Protection." If Division 01 Section is not included, trees to be saved that are buried in fills over 12 inches deep shall be protected by a dry-stone wall placed at least 36 inches from the tree trunk. All wells are to be properly drained. Before fills of over 12 inches are made upon the tree root areas, at least a 6-inch layer of broken stones or coarse gravel covered by inverted sods shall be spread to facilitate proper drainage and aeration. The area to be treated in this manner shall be extended to the drip line.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Architect.

**3.4 EXISTING UTILITIES**

- A. Contractor shall arrange for disconnecting and sealing indicated utilities that serve existing structures before site clearing. Coordinate with Owner.
  - 1. Verify that utilities have been disconnected and capped before proceeding with site clearing.
- B. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
  - 1. Arrange with utility companies to shut off indicated utilities.
- C. Locate, identify, and disconnect utilities indicated to be abandoned in place.
- D. Interrupting 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. Do not proceed with utility interruptions without Architect's written permission.



- E. Excavate for and remove underground utilities indicated to be removed.

**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, obstructions, and debris to a depth of 18 inches below exposed subgrade.
  - 3. Use only hand methods for grubbing within protection zones.
  - 4. Chip removed tree branches and dispose of off-site.
- 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, and compact each layer to a density equal to adjacent original ground.

**3.6 TOPSOIL STRIPPING**

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to required depth to prevent intermingling with underlying subsoil or other waste materials.
  - 1. Remove subsoil and nonsoil materials from topsoil, including clay lumps, gravel, and other objects more than 2 inches in diameter; trash, debris, weeds, roots, and other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. 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.
  - 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.

**3.7 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.

**3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS**

- A. 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.
- B. 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 31 10 00**  
07/10/2018

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## **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. State of Connecticut Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form 817.
- C. American Society for Testing and Materials (ASTM) Standards:
  - 1. ASTM C 136: Method for sieve analysis of fine and coarse aggregates.
  - 2. ASTM C 117: Standard test method for materials finer than No. 200 sieve in mineral aggregate washing.
  - 3. ASTM D 422: Standard test method for particle size analysis of soils.
  - 4. ASTM D 1140: Test for amount of material in soils finer than No. 200 sieve.
  - 5. ASTM D 1556: Test method for density of soil in place by the sand cone method.
  - 6. ASTM D 1557: Test methods for moisture-density relations of soils and soil aggregate mixtures using 10 lb. hammer and 18-inch drop. AASHTO Standard T-180 may be substitute for ASTM D 1557.
  - 7. ASTM D 2922: Test methods for density of soil and soil-aggregate in place by nuclear methods (shallow depth).
  - 8. ASTM D 4318: Test method for liquid limit, plastic limit and plasticity index of soils.

### **1.2 SUMMARY**

- A. Section Includes:
  - 1. Preparing subgrades for equipment pads, walks, pavements, turf and grasses and plants.
  - 2. Excavating and backfilling for structures.
  - 3. Base and subbase course for concrete walks and pavements.
  - 4. Subbase course and base course for asphalt paving.
  - 5. Subsurface drainage backfill for walls and trenches.
  - 6. Excavating and backfilling trenches for utilities and pits for buried utility structures.
  - 7. Excavation and off-site disposal of all unsuitable and excess materials, and stockpiling of all suitable on-site materials required for reuse.
  - 8. Provision, transportation and placement of all required fill and backfill materials.
  - 9. Drainage and dewatering required to perform the work in the dry.

### **1.3 UNIT PRICES**

- A. Work of this Section is affected by unit prices for earth moving specified in Section 012200 "Unit Prices."
- B. Quantity allowances for earth moving are included in Section 012100 "Allowances."
- C. Rock Measurement: Volume of rock actually removed, measured in original position. See Part 3 for rock paylimits. Unit prices for rock excavation include replacement with approved materials. Unit prices for rock are included in Division 01 Section "Unit Prices."

### **1.4 DEFINITIONS**

- A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
- 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. 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 Geotechnical Engineer and/or Owner's Testing Agency. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
  - 2. Bulk Excavation: Excavation more than 10 feet.
  - 3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Geotechnical Engineer and/or Owner's Testing Agency. Unauthorized excavation, as well as remedial work directed by Geotechnical Engineer and/or Owner's Testing Agency, shall be without additional compensation.
- F. Fill: Soil materials used to raise existing grades.
- G. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 1 cu. yd. for bulk excavation or 3/4 cu. yd. 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. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom; measured according to SAE J-1179.
  - 2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp flywheel power and developing a minimum of 47,992-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.
- H. Structures: Retaining walls, equipment pads, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- I. Subbase Course: Aggregate layer placed between the subgrade and base course.
- J. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within building limits.

#### 1.5 ACTION SUBMITTALS

- A. Product Data: For each type of the following manufactured products required:
  - 1. Warning tapes.
- B. Earth Material Samples: Contractor shall be responsible for obtaining samples (50 pounds minimum) of earthwork materials proposed to be used and transporting them to the site 7 calendar days in advance of the time planned for incorporating them into the work. Use of proposed materials by the Contractor prior to testing and approval or rejection shall be at the Contractor's risk. The following information shall be submitted:
  - 1. Location of borrow source site.
  - 2. Present and past usage of the source site and material.
  - 3. Any previously existing report(s) associated with an assessment of the source site, as relates to the presence of oil or hazardous material.
  - 4. Location within the source site from which the material will be obtained.

- C. Up to three test series (gradation and laboratory compaction) will be completed by the Geotechnical Engineer or Owner's Testing Agency for off-site borrow sources for each category of earth materials defined in Part 2 of this Section at the Owner's cost. Testing of additional samples or sources shall be at the Contractor's cost.
  - 1. Sieve analysis to be based on washed sieve analysis in accordance with appropriate ASTM standard.

#### 1.6 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 D 2487.
  - 2. Laboratory compaction curve according to ASTM D 1557.
- C. 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.
- D. Flowable Fill Mix Design: Submit mix design with admixture information for review and approval a minimum of 15 days prior to start of work.

#### 1.7 QUALITY ASSURANCE

- A. Geotechnical Testing Agency Qualifications: Qualified according to ASTM E 329 and ASTM D 3740 for testing indicated.
- B. Earthwork Observation and Testing:
  - 1. The Owner will retain a qualified Geotechnical Engineer and/or Testing Agency to perform on-site observation and testing during work under this and related sections and as indicated in the "Schedule of Special Inspections." The services of the Geotechnical Engineer and/or Owner's Testing Agency may include, but not be limited to the following:
    - a. Observation during excavation, subgrade preparation and backfill for footings, pavements, walks, utility trenches, equipment pads and subsurface drainage construction, etc.
    - b. Determination of requirements for additional excavation to remove unsuitable materials.
    - c. Observation and testing during placement and compaction of fill and backfill.
    - d. Laboratory testing and analysis of fill material specified.
    - e. Review of submittals.
  - 2. During the course of construction, the Geotechnical Engineer and/or Owner's Testing Agency shall advise the Owner's Agent, in writing, with a copy to the Architect and Contractor, if at any time, in his opinion, the work is not in substantial conformity with the plans and specifications. The Geotechnical Engineer's and/or the Owner's Testing Agency's presence does not include supervision or direction of the actual work by the Contractor, his employees, subcontractors or agents. Neither the presence of the Geotechnical Engineer and/or Owner's Testing Agency, nor any observations and testing performed by him shall excuse the Contractor from defects discovered in his work.
  - 3. Testing equipment will be provided by and testing performed by the Geotechnical Engineer and/or Owner's Testing Agency, except as otherwise provided by contract. Upon request by Owner's Agent, the Contractor shall provide such auxiliary personnel and services as needed to accomplish testing work and to repair damage caused thereby to permanent work.
  - 4. References herein to observations, testing, and determinations by the "Engineer" include services to be provided by the Geotechnical Engineer and/or Owner's Testing Agency when appropriate and when so authorized by the Engineer or Owner.
  - 5. The Contractor shall not proceed without the Testing Agency in place. Contractor to coordinate with Testing Agency.

- C. Preexcavation Conference: Conduct conference at Project site.
1. Before commencing tree clearing and grubbing, have tree clearing limits staked and meet with representatives of the governing authorities, Owner, Engineer and other concerned entities to review the area in question. Notify the participants at least three working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.
  2. Before commencing earthwork, meet with representatives of the governing authorities, Owner, Architect, Engineer, consultants, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Record discussions and agreements and furnish a copy to each participant.

## 1.8 PROJECT CONDITIONS

- A. Existing Utilities:
1. Notify utility locator service for area where project is located before site clearing or excavating. Hire private utility mark-out service for areas not marked by utility companies. See General Conditions of the construction contract.
  2. Before starting excavation, establish location and extent of any underground utilities occurring in work area. Make arrangements with appropriate utility company for removal and relocation of lines which are in the way of excavation. If utilities are to remain in-place, provide adequate means of support and protection during earthwork operations.
  3. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult utility owner immediately for directions. Cooperate with Owner, Owner's Agent, and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
  4. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped. The location of such utilities shall be noted on record drawings and reported in writing to Owner's Agent. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff of services if lines are inactive.
  5. Do not interrupt existing utilities serving facilities occupied and used by Owner or others, during occupied hours, except when permitted in writing by Owner's Agent and then only after arranging to provide acceptable temporary utility services. Provide minimum of 48 hours notice to Owner's Agent and receive written notice to proceed before interrupting any utility. Do not proceed with utility interruptions without Owner' written permission.
  6. When in the course of the work it is necessary to connect a utility to a main in a public way, all the requirements of both the authorities governing the utility and those governing the public way shall be met. Pavement shall be temporarily and permanently replaced as directed by these authorities at no additional cost to the Owner.
- B. Site Information:
1. Information in the Contract Plans and in the Specifications relating to subsurface conditions, existing utilities and structures is from the best sources presently available. Such information is furnished only for the information and convenience of the Contractor, and the accuracy and completeness of this information is not guaranteed.
- C. 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.
- D. Improvements on Adjoining Property: Authority for performing earth moving indicated on property adjoining Owner's property will be obtained by Owner and Contractor before award of Contract.
1. Do not proceed with work on adjoining property until directed by Architect.

- E. Do not commence earth moving operations until temporary erosion- and sedimentation-control measures, specified in Section 311000 "Site Clearing," are in place.
- F. Do not commence earth moving operations until plant-protection measures are in place.
- G. 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.
- H. Do not direct vehicle or equipment exhaust towards protection zones.
- I. Prohibit heat sources, flames, ignition sources, and smoking within or near protection zones.

**PART 2 - PRODUCTS**

**2.1 SOIL MATERIALS**

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations. All rock and soil materials furnished for use as fill or backfill shall be free of grease, oil, solvents, pesticides, herbicides or other hazardous or deleterious materials and/or contaminants. All rock and soil materials specified in this Section shall also be free from ice, snow, trash, debris, stumps, roots and organic material.
- B. Satisfactory Soils: Soil Classification Groups GW, GP, GM, SW, SP, and SM according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.
- C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, contaminated soils or a combination of these groups. Symbols shall not be used as fill or backfill except where impervious fill is specified or detailed. Satisfactory soils which have been rendered wet, such that the contractor cannot establish a stable soil mass compacted as specified in this Section, also shall not be used as fill or backfill.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Backfill and Fill: Satisfactory soil materials.
- E. 3/4-Inch Crushed Stone: Crushed stone shall be a quarry product or washed gravel stone obtained from offsite sources for use as detailed on the drawings. Crushed stone shall consist of durable crushed rock or gravel stone essentially free of silt, clay, loam or other deleterious materials and shall conform to the following gradation requirements for the nominal size indicated.

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 1 Inch	100
Pass 3/4 Inch	90 - 100
Pass 1/2 Inch	20 - 55
Pass 3/8 Inch	0 - 15
Pass No. 4	0 - 5

- F. Base: Naturally or artificially graded non-plastic mixture of durable, sound coarse and fine aggregate and obtained from suitable excavated onsite soils or offsite sources. Mixture to be free of debris, waste, frozen materials, and organics, and shall be well graded within the following limits (processed stone, no gravel):

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 2-1/2 Inch	100
Pass 2 Inch	95 - 100
Pass 3/4 Inch	50 - 75
Pass 1/4 Inch	25 - 45
Pass No. 40	5 - 20
Pass No. 100	2 - 12

- G. Subbase: Subbase material for use as pavement subbase course and other uses as detailed shall be obtained from suitable excavated onsite soils or offsite sources. Base shall consist of a non-plastic mixture of durable, sound coarse and fine aggregate with no more than 15 percent by weight of recycled bituminous concrete and shall be well graded within the following limits:

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 3-1/2 Inch	100
Pass 1-1/2 Inch	55 - 100
Pass 1/4 Inch	25 - 60
Pass No. 10	15 - 45
Pass No. 40	5 - 25
Pass No. 100	0 - 10
Pass No. 200	0 - 5

- H. Bedding Material: Well-graded gravels and gravel sand mixtures free of debris, waste, frozen materials, and organics within the following limits:

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 1-1/2 Inch	100
Pass No. 4	10 - 50
Pass No. 200	0 - 5

- I. Granular Fill (Also Termed Structural Fill): Granular fill shall be obtained from suitable excavated onsite soil or offsite borrow sources for use as fill and backfill below and interior to building areas except where other materials are specified or detailed, and as details on the drawings. Granular fill shall consist of non-plastic naturally or artificially graded mixture of sound coarse and fine aggregates free of debris, waste, frozen materials and organics and conforming to the following gradation:

SQUARE MESH SIEVES	PERCENT FINER BY WEIGHT
Pass 3-1/2 Inch	100
Pass 1-1/2 Inch	55 - 100
Pass 1/4 Inch	25 - 60
Pass No. 10	15 - 45
Pass No. 40	5 - 25
Pass No. 100	0 - 10
Pass No. 200	0 - 5

- J. General Fill: Clean, sound mixture of material free of debris, waste, frozen materials and organics with 5-inch maximum size aggregate and not more than 12 percent passing the No. 200 sieve.

- K. Flowable / Excavatable Fill: Mixture of cement, GranCem, sand, water and admixtures to produce a flowable / excavatable fill with a compressive strength at 28 days of 100 psi to 150 psi.

**2.2 ACCESSORIES**

- A. Detectable Warning Tape: Acid- and alkali-resistant, polyethylene film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 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, detectable by metal detector when tape is buried up to 30 inches deep; colored as follows:

1. 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.
- D. Provide protective construction fence around all landscaping in work area to remain.

#### **3.2 DEWATERING**

- A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.
- B. 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. The contractor shall grade and ditch the site as necessary to direct surface runoff away from open excavations. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding project site and surrounding areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
  2. The Contractor shall provide, at his own expense, adequate pumping and drainage facilities to keep all excavations and work sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction product or procedures nor cause excessive disturbance of underlying natural ground or footing and slab subgrades. Contractor shall similarly control water entering the excavation as a result of construction operations, such as washing of concrete equipment and tools and the like.
  3. Protect subgrades and foundation soils from softening, undermining, washout, and damage by water accumulation.
  4. Install dewatering as required to keep subgrades dry and convey groundwater away from excavations. Maintain until dewatering is no longer required.
  5. Water from trenches and excavations shall be disposed of in such a manner as will not cause injury to public health, nor damage to public or private property, existing work, or work in progress, nor to the surface of roads, walks and streets, nor cause any undue interference with the use of the same by the public. The Contractor shall comply with all applicable environmental protection and/or sediment/erosion control regulations.
  6. Under no circumstances place concrete or fill, or lay piping or install appurtenances in excavations containing free water. Keep utility trenches free from water until pipe joint material has hardened.

#### **3.3 EXPLOSIVES**

- A. Explosives: Do not use explosives.

#### **3.4 EXCAVATION, GENERAL**

- A. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not disintegrate or excavate rock until it has been classified by the Geotechnical Engineer and/or Owner's Agent and cross-sectioned by the Owner's registered land surveyor. The



Contract Sum will be adjusted for rock excavation according to contract provisions for changes in the work. Changes in the Contract Time may be authorized for rock excavation.

1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
  - a. Intermittent drilling; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
2. Rock excavation includes removal and disposal of rock and includes replacement with approved materials.
  - a. Uncover and expose all rock surfaces to be removed.
  - b. Notify Owner in writing before rock removal proceeds.
  - c. The Owner will engage a registered land surveyor to cross section the top of rock and determine the quantity of rock for payment. Measurements for payment will be based on in place cubic yards of rock removed to paylines, as defined:
    - 1) For Walks, Pavements and Equipment Pads: The measurement will be taken vertically 12 inches below slab subgrade elevation as indicated in the Contract Documents.
    - 2) For Utility Trenches: The measurement will be taken vertically 6 inches below bottom of pipe and horizontally 24 inches wider than the nominal diameter of pipe/conduit as indicated in the Contract Documents.
    - 3) For Structures: The measurement will be taken horizontally 24 inches greater in both length and width or diameter than the actual exterior dimensions of the structures and vertically 12 inches below bottom elevation of structure as indicated in the Contract Documents.
  - d. No payment will be made for overblasted rock and/or shattered layers below paylimits, associated removal and replacement with suitable fill material.

**B. Dimensions:**

1. Excavate to elevations and dimensions indicated on the drawings or as otherwise required for the work. Do all necessary excavation, including, but not limited to, excavation for structures, footings, foundations, grade beams, walls and slabs below grade, paving, utility lines, mechanical work, mechanical and drainage structures, drains, and other below grade work. Excavate sufficient material so as to allow ample space for construction operations including placing and removal of forms, installation of waterproofing, dampproofing or utilities and inspection of excavated areas.
2. Side forms will be required for all concrete work unless omission of forms is requested by the Contractor, in writing, to the Engineer. Where omission of forms is requested by the Contractor, and accepted by the Engineer, the Contractor shall bear the cost of any additional concrete volume required beyond the minimum profiles and dimensions of the footing, wall, or utility trench as detailed.

**C. Disposition of Excavated Material:**

1. Sort and stockpile excavated material according to its suitability for re-use and job requirements. Onsite stockpile room will be limited and the Contractor shall plan his operations to facilitate prompt reuse of excavated material or provide offsite stockpile locations as required.
2. Stockpile soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.
4. Offsite Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris and legally dispose of it off Owner's property.

- D. **Unauthorized Excavation:** Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimension without specific direction of the Engineer or Owner's agent. Unauthorized excavation, as well as remedial work specified by the Engineer, shall be at the Contractor's expense.
1. In areas below structures, pavements and walks, backfill unauthorized excavation with granular fill placed and compacted in accordance with this Section, unless otherwise directed by the Engineer.
  2. Elsewhere, backfill and compact unauthorized excavations with general fill, compacted to the requirements of this Section.
  3. Where the excavation of otherwise suitable materials is required due to these materials being rendered unsuitable due to disturbance, construction activity, freezing, or lack of protection from the elements, the Contractor shall excavate these materials and provide remedial work as specified above at no additional cost to the Owner.
- E. **Authorized Additional Excavation:** In the case that unsuitable materials, as determined by the Engineer, are encountered at the specified subgrade elevation, the Engineer may direct the removal of the unsuitable material and refill will granular fill placed and compacted in accordance with the requirements of this Section. Authorized addition excavation with granular fill backfill will be paid according to contract provisions for changes in the work.
- F. **Backfilling Prior to Acceptance of Work Installed:**
1. Do not allow or cause the work performed or installed to be covered up or enclosed by work of this Section prior to all required inspections, tests, and acceptances.
  2. Should any of the work be so enclosed or covered up before it has been accepted, uncover all such work at no additional cost to the Owner.
  3. After the work has been completed, tested, inspected, and accepted, make all repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering, all at no additional cost to the Owner.
- G. **Sheeting, Shoring, and Bracing:**
1. Provide sheeting, shoring and/or bracing at excavations as required to assure safety against collapse of earth or rock at sides of excavations; as required for support of adjacent structures, streets, or utilities; or as required to comply with federal, state or local regulations, codes or ordinances.
  2. Provide materials for sheeting, shoring and bracing, such as sheet piling, uprights, stringers and cross braces, in good serviceable condition. Maintain shoring and bracing in excavations regardless of time period excavations will be open. Carry down sheeting, shoring and bracing as excavation progresses.
  3. All sheeting and bracing not ordered left in place shall be carefully removed in such a manner as not to endanger the construction of other structures, utilities or property whether public or private. All voids left after withdrawal of sheeting shall be immediately refilled with sand and rammed with tools especially adapted to that purpose or otherwise compacted as directed to achieve the required density.
  4. Wood sheeting shall not be completely withdrawn if driven below mid-diameter of any pipe, and under no circumstances shall any wood sheeting be cut off at a level lower than one foot above the top of pipe.
  5. Refer to related requirements in Section 315000 "Excavation Support and Protection."
- H. **Dust and Erosion Control:**
1. The Contractor shall take all necessary measures and provide equipment and/or materials to minimize dust from rising and blowing across the site and also to control surface water throughout the operation so that it does not run onto paved ways without being filtered. In addition, the Contractor shall control all dust created by construction operations and movement of construction vehicles, both on site and on paved ways.
  2. Thoroughly moisten all surfaces as required to prevent dust being a nuisance to the public, neighbors and performance of other work on the site.

3. Repair any broken or damaged sections of hay bales or other erosion and siltation control measures damaged during excavation and grading operations and install any additional sections necessary for proper control.

I. Frost Protection and Snow Removal:

1. The Contractor shall, at his own expense, keep the operations under this contract clear and free of accumulations of snow or as required to carry out the work.
2. Do not excavate to full indicated depth when freezing temperatures may be expected, unless footings or slabs can be cast immediately after excavation has been completed. Protect the excavation from frost if placing of concrete is delayed. Do not cast concrete on frozen ground.
3. Completed foundations which have not been backfilled or which have less than 42 inches of earth cover above the bottom of the foundation shall be protected from freezing by temporary additional earth cover, insulating blankets, heaters, or other methods. See Section 033000 for additional requirements.

J. Protection of Persons and Property:

1. The work shall be executed in such manner as to prevent any damage to adjacent property and any other property and existing improvements, such as but not limited to, streets, curbs, paving, service utility lines, structures, monuments, bench marks and other public or private property. Protect existing improvements from damage caused by settlement, lateral movements, undermining, washout, vibration and other hazards created by earthwork operations.
2. In the case of any damage or injury caused in the performance of the work, the Contractor shall, at his own expense, make good such damage or injury to the satisfaction of and without cost to, the Owner. Existing roads, sidewalks, and curbs damaged during the project work shall be repaired or replaced to their original condition at the commencement of operations. The Contractor shall replace, at his own expense, existing bench marks, monuments and other reference points which are disturbed or destroyed.
3. Barricade open excavations occurring as part of this work and post with warning lights. Operate warning lights during hours from dusk to dawn each day and otherwise as required.
4. Buried structures, utility lines, etc., including those which project less than 18 inches above grade, which are subject to damage from construction equipment shall be clearly marked to indicate the hazard.
5. Provide protective construction fence around all landscaping in work area to remain.

**3.5 EXCAVATION FOR STRUCTURES**

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. 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. General: 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.

B. Excavation for Structures and Piping, Etc.:

1. Excavate to elevations and dimensions indicated within a tolerance of plus or minus one inch. Do not disturb bottom of excavations intended for bearing surface.
2. Allow the Geotechnical Engineer to view the excavated subgrade. The Geotechnical Engineer shall determine whether authorized additional excavation is required to remove unsuitable material. Remove and replace such unsuitable material as directed by the Engineer.

C. Excavations at Edges of Tree- and Plant-Protection Zones:

1. Excavate by hand to indicated lines, cross sections, elevations, and subgrades. 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.

### 3.6 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks, pavements and equipment pads to indicated lines, cross sections, elevations, and subgrades.
  - 1. Walks, pavements and equipment pads shall be supported on subbase/base course(s) as indicated on the drawings.
  - 2. Remove and replace excessively wet, disturbed or unstable material and proof compact the subgrade for the subbase/base course with at least six passes of a vibratory plate or vibratory roller compactor immediately prior to placement of slab base course material unless otherwise directed.
  - 3. The final surface of the subgrade for the walks, pavements and equipment pads shall be proof rolled with at least four passes of an approved vibratory plate or vibratory drum compactor immediately prior to placing the reinforcing and/or concrete (as may be applicable).

### 3.7 EXCAVATION FOR UTILITY TRENCHES

- A. Excavate trenches to indicated gradients, lines, depths, and elevations.
- B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe, conduit or ductbank. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe, conduit or ductbank unless otherwise indicated.
  - 1. Clearance: As indicated on Contract Documents.
- C. Trench Bottoms: Excavate trenches to depth indicated on Contract Documents to allow for bedding course. Hand-excavate deeper for bells of pipe.
- D. Trenches in Tree- and Plant-Protection Zones:
  - 1. Hand-excavate to indicated lines, cross sections, elevations, and subgrades. 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 installation of utilities.
  - 3. Cut and protect roots according to requirements in Section 015639 "Temporary Tree and Plant Protection."

### 3.8 SUBGRADE INSPECTION

- A. Notify Geotechnical Engineer and/or Owner's Testing Agency when excavations have reached required subgrade.
- B. If Geotechnical Engineer and/or Owner's Testing Agency determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed and in accordance with excavation requirements of this Section.
- C. Unforeseen additional excavation and replacement material will be paid for according to contract provisions for changes in the work.
- D. Proof-roll subgrade as directed by the Geotechnical Engineer and/or Owner's Testing Agency.
- E. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices.
- F. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Geotechnical Engineer and/or Owner's Testing Agency, without additional compensation.

**3.9 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.

**3.10 PLACEMENT AND COMPACTION OF FILL AND 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.
  - 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 and 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.
- C. Unless otherwise specified or indicated on the drawings, the products specified in Part 2 of this Section shall be employed in the various fill and backfill applications indicated in the part. Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass, use common fill material.
  - 2. Under walks, use base material.
  - 3. Under pavements, use subbase and base material.
  - 4. Under footings, use granular fill.
  - 5. Under utilities, use either bedding material or crushed stone (see drawings).
  - 6. Under equipment pads and structures, use crushed stone.
- D. All vegetation, peat, organic topsoil or subsoil, trash, debris, roots, stumps, and any compressible or otherwise deleterious materials shall be stripped from the existing ground surface and removed from excavations prior to placement of fill or backfill.
- E. All fill and backfill materials shall be placed in horizontal layers. Each layer shall be spread evenly and thoroughly mixed during spreading to ensure uniformity of material in each layer. Layer thickness shall not exceed that specified in Paragraph L of this Section.
- F. Where horizontal fill layers meet a natural or excavated slope, the layer shall be keyed into the slope by cutting a bench. The surface of benches shall be compacted to the same requirements as apply to the area being filled.
- G. In no instance place fill over materials that were permitted to freeze prior to compaction or over ice or snow. Removal of such materials will be required as directed by the Engineer. In no case will frozen material be allowed for use in fill or backfill.
- H. No fill shall be placed or compacted during unfavorable weather conditions. When work is interrupted by heavy rains or snow, fill operations shall not be resumed until the moisture content and density of previously placed fill are as specified hereinafter.

- I. Allow the Geotechnical Engineer and/or Owner's Testing Agency sufficient time to make necessary observations and tests. The degree of compaction shall be based on a maximum dry density as determined by ASTM D 1557 or AASHTO Standard T180. All fill and backfill placed in various areas shall be compacted in individual layers to minimum dry densities as follows:
1. Under Equipment Pads, Structures, Steps and Pavements, Within Building Foundations Backfill Limits (Other Than Stone Base): 95 percent.
  2. Under and Around Utilities (Other Than Stone): 95 percent.
  3. Under Walkways: 92 percent.
  4. Under Lawn or Unpaved Areas: 90 percent.
  5. Uniformly graded crushed stone materials which are not suited to field density testing shall be compacted in accordance with the minimum compactive effort indicated in Paragraph 3.11 L of this Section.
- J. The term "under," as applied to buildings, structures and paved areas, shall be construed to include all materials immediately below the plan area of the building, as well as those materials within a line sloping at one vertical and one horizontal drawn downward and outward from the exterior of building foundation, structure foundation or paved area.
- K. Compaction shall be by mechanical means designed specifically for compaction and approved by the Engineer. The Engineer reserves the right to disapprove any device of inadequate capacity or of type unsuited to the character of the material being compacted. In areas which are too restricted to permit the use of mechanical compactors, fill may be placed in 3-inch layers and compacted by hand rammer or pneumatic tools.
- L. In addition to the stated degree of compaction, all fill and backfill shall receive at least the compactive effort given in the following table. Lift thickness shall not exceed that shown for the compaction method selected, except that the first lift of fill or backfill placed over natural ground in wet conditions may be as much as 12 inches thick. Application of the minimum compactive effort does not relieve the Contractor from his requirement to achieve the specified degree of compaction.

Compaction Method	Maximum Stone Size	Maximum Loose Lift Thickness		Minimum Number of Passes	
		Below Structures and Pavement	Less Critical Areas	Below Structures and Pavement	Less Critical Areas
Hand-operated vibratory plate or light roller in confined areas	4"	6"	8"	6	4
Hand-operated vibratory drum rollers weighing at least 1,000 lbs.	6"	8"	10"	6	4
Light vibratory drum roller, minimum dynamic force 3,000 lbs. per ft. of drum width	6"	10"	14"	6	4
Medium vibratory drum roller, minimum dynamic force 5,000 lbs. per ft. of drum width	8"	12"	18"	6	4
Large vibratory drum roller, minimum dynamic force 8,000 lbs. per ft. of drum width	10"	16"	24"	6	4

M. Moisture Control:

1. Water shall be added to fill material which does not contain sufficient moisture to be compacted to the specified densities. Fill and backfill material containing excess moisture shall be required to dry prior to or during compaction to a moisture content not greater than two percentage points (2%) above optimum except that material which displays pronounced elasticity or deformation underfoot or under load shall be required to dry to optimum moisture content before it is placed and compacted, if that is required to achieve specified compaction. At the Contractor's option, material which is too wet may be removed and replaced with satisfactory material at no additional cost to the Owner.
2. The Contractor is alerted to the potential silty nature of the on-site soil which renders them sensitive to moisture. On-site silty soils are difficult to handle and compact and are easily disturbed when wet. The Contractor shall plan and conduct his excavation and filling operations considering the nature of the onsite materials.

- N. Where the Engineer, Geotechnical Engineer and/or Owner's Testing Agency determines that fill or backfill does not conform to the compacted density specified, or did not receive the minimum compactive effort specified, such fill shall be removed and replaced with conforming materials at the Contractor's own cost.

**3.11 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING CONSTRUCTION**

- A. The Contractor shall take the necessary steps to avoid disturbance of subgrade during excavation and filling operations. Methods of excavation and filling shall be revised as necessary to avoid disturbance of the subgrade, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials, dewatering and other acceptable control measures. The Contractor shall cooperate with the Engineer to modify his operations as necessary to mitigate disturbance and protect bearing soils, based on the Engineer's observations.
- B. All excavated or filled areas disturbed during construction; damaged by freezing temperatures, frost, rain, accumulated water, or construction activities; all loose or saturated soil, and other areas that do not meet compaction requirements as specified herein shall be removed and replaced with compacted fill materials specified. Costs of removal of disturbed material and refill with compacted fill shall be borne by the Contractor.

**3.12 UTILITY TRENCH BACKFILL**

- A. Place backfill on subgrades 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 and ductbanks.
- C. Do not excavate trenches under new or existing footings unless approved by Engineer. If approved, backfill trenches excavated under footings and within 18 inches of bottom of footings; fill with concrete to an elevation of 4 inches above bottom of footings.
- D. Backfill voids with satisfactory soil while removing shoring and bracing.
- E. Place and compact initial backfill of material as shown on the drawings, free of particles larger than 1 inch in any dimension, to a height over the pipe or conduit as indicated in the Contract Documents.
1. 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 utilities testing.
- F. Place and compact final backfill of satisfactory soil to final subgrade elevation.
- G. Coordinate backfilling with utilities testing.

**3.13 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 required elevations within the following tolerances:
  - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
  - 2. Walks: Plus or minus 1 inch.
  - 3. Pavements: Plus or minus 1/2 inch.

**3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS**

- A. On prepared subgrade, place subbase course and base course under pavements and walks as follows:
  - 1. Place base course material over subbase course under hot-mix asphalt pavement.
  - 2. Shape subbase course and base course to required crown elevations and cross-slope grades.
  - 3. Place subbase course and base course 6 inches or less in compacted thickness in a single layer.
  - 4. Place subbase course and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 5. 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 density according to ASTM D 1557.
- B. Pavement Shoulders: Place shoulders along edges of subbase course and base course to prevent lateral movement. Construct shoulders, at least 12 inches wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry density according to ASTM D 1557.

**3.15 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. 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.
- C. Footing Subgrade: At footing subgrades, each soil stratum will be verified by Geotechnical Engineer and/or Owner's Testing Agency based on the required design bearing capacities.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.
  - 1. Field in-place density tests may also be performed by the nuclear method according to ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D 1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 3017.
  - 2. When field in-place density tests are performed using nuclear methods, make calibration checks for both density and moisture gages at beginning of work, on each different type of material encountered, and at intervals as directed by the Engineer.
- E. Tests will be performed at the following locations and frequencies, subject to the discretion of the Geotechnical Engineer and/or Owner's Testing Agency.



1. Paved Areas and Walks: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
2. Trench Backfill and Base: At each compacted initial and final backfill layer, at least one test for every 150 feet 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.

**3.16 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 Geotechnical Engineer and/or Owner's Testing Agency; 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.

**3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS**

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

**END OF SECTION 31 20 00**  
07/10/2018

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. The work under this Section includes, but is not limited to, the following:
  - 1. Provide all labor, equipment and materials for the installation of required site related erosion control measures if not otherwise directed on the plans. Erosion control shall be in strict conformance with the latest revision of the local and state guidelines for soil erosion and sediment control.
- B. All sedimentation and erosion control measures and installations shall conform to the 2002 Connecticut Guidelines for Soil Erosion and Sediment Control.
- C. Erosion and sediment control techniques include, but are in no way limited to, silt fence, hay bales, drainage structure inserts/filters, mulching with hay/straw, netting/matting, grassing, stone dikes/berms/check-dams, compost blankets and berms, barriers, diversions, traps, basins, and appurtenances which will ensure that erosion and sediment pollution will be either eliminated or maintained within acceptable limits.

**1.2 GENERAL NOTES**

- A. The discharge of sediment-laden water from the project site is prohibited. All discharged water from dewatering operations shall discharge into approved dewatering measures as required by the latest revision of the local and state guidelines for soil erosion and sediment control.
- B. The Contractor shall install all erosion control measures as depicted on the plans and as required to adhere to latest revision of the local and state guidelines for soil erosion and sediment control.
- C. The Contractor shall also be responsible for inspecting and maintaining all erosion control measures until the project is completed.

**1.3 SUBMITTALS**

- A. Submit material specifications and shop drawings for all products furnished under this Section.

**1.4 QUALITY CONTROL**

- A. Contractor shall be responsible for the timely installation and maintenance of all sedimentation control devices necessary to prevent the erosion of soil or movement of sediment from construction activities to off-site areas via surface runoff or underground drainage systems. Measures in addition to those shown on the Drawings necessary to prevent the movement of sediment off site shall be installed, maintained, removed, and cleaned up at the expense of Contractor.
- B. Engineer has the authority to order immediate, additional, temporary control measures to prevent contamination of adjacent streams or other watercourses, or other areas of water impoundment and damage by erosion.
- C. If Engineer observes construction procedures and operations that jeopardize erosion control provisions, Engineer will notify Contractor. If such construction procedures and operations are not corrected promptly, Engineer may suspend the performance of any or all construction until corrections have been made, and such suspension shall not be the basis of any claim by Contractor for additional compensation, nor for an extension of time to complete the Work.
- D. Should construction materials be washed away or otherwise rendered ineffective in the opinion of Engineer during the progression of the Work, Contractor shall replace the installations at no additional cost to the Owner.

**1.5 COORDINATION WITH PERMANENT EROSION CONTROL PROVISIONS**

- A. The temporary control provisions shall be coordinated with the permanent erosion control features to the extent practical to ensure economical, effective and continuous erosion control throughout the construction and post-construction period.

**PART 2 - PRODUCTS**

**2.1 EROSION CONTROL BLANKETS**

- A. Temporary Erosion Control Blanket shall be 1) Curlex® Excelsior Blanket, as manufactured by American Excelsior Company, 2) ERO-MAT® V75S(FD), as manufactured by Verdyol Plant Research, Ltd., or 3) Landlok® S2 RD, as manufactured by SI® Geosolutions.
- B. Degradable Erosion Control Fabric Netting shall be Landlok® 407 GR, as manufactured by 1) SI® Geosolutions, or 2) GeoJute® as manufactured by Belton Industries, Inc., or 3) BioNet® S150BN™ Double Net Straw Blanket, as manufactured by North American Green.
- C. Long-Term and Non-degradable Turf Reinforcement Mats shall be 1) Pyramat®, as manufactured by SI® Geosolutions, or 2) Recyclex® Turf Reinforcement Matting, as manufactured by American Excelsior Company, or 3) Vmax3 C350™, as manufactured by North American Green.
- D. Erosion control matting shall be secured with staples or an alternative attachment device such as geotextile pins or plastic pegs as recommended by the manufacturer. The Contractor shall submit a sample of the alternative attachment device for the Engineer's approval prior to installation.

**2.2 FILTER FABRIC**

- A. When filter fabric is required, it shall conform to the requirements of the following:
- B. Mechanical and Physical Properties of Filter Fabric Nonwoven Geotextile:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Grab Tensile Strength	ASTM D 4632	Pounds	120
Grab Elongation (Max percent)	ASTM D 4632	Percent (%)	50
Trapezoidal Tear	ASTM D 4533	Pounds	50
Puncture	ASTM D 6241	Pounds	310
Permittivity	ASTM D 4491	Sec-1	1.7
Flow Rate	ASTM D 4491	gal/min/ft2	135
Apparent Opening Size	ASTM D 4751	(U.S. Sieve)	70
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70

**2.3 SILT FENCE**

- A. Woven Polypropylene geotextile having a minimum weight of 3.1 ounces per square yard conforming to the following:
- B. Mechanical and Physical Properties of Silt Fence Geotextile:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Weight	ASTM D 3776	oz/yd2	5.6
Grab Tensile Strength	ASTM D 4632	Pounds	60
Grab Elongation (Max percent)	ASTM D 4632	Percent (%)	15-30
Trapezoidal Tear	ASTM D 4533	Pounds	30

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Puncture	ASTM D 4833	Pounds	30
Mullen Burst	ASTM D 3786	psi	150-200
Permittivity	ASTM D 4491	Sec-1	0.15
Flow Rate	ASTM D 4491	gal/min/ft2	15-20
Apparent Opening Size	ASTM D 4751	(U.S. Sieve)	30-35
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70

- C. Silt fence shall be constructed of a minimum thirty-six (36) inch wide continuous woven geotextile. The material shall have a high sediment filtration capacity, high slurry flow and minimum clogging characteristics. Edges of the fabric shall be finished to prevent the outer fibers from pulling away from the geotextile. Geotextile shall be free of defects or flaws that significantly affect its physical and/or filtering properties.
- D. Fabric shall be securely fastened to stakes a minimum of 42 inches long and made of hardwood with a minimum dimension of 1½ inch by 1½ inch normal size such that a 12 inch length of fabric is unattached at the bottom for anchorage in soil. Metal stakes may be used instead of wooden stakes. Metal stakes shall be round, "U", "T", "L", or "C" shaped with a minimum weight of 0.5 pounds per foot. Stakes shall be spaced not greater than eight feet apart. When required, wire or another type of support shall be constructed between the geotextile fabric and the posts to improve the load carrying capacity of the silt fence.

**2.4 SEPARATION FABRIC**

- A. When separation fabric is required, it shall conform to the requirements of the following:
- B. Mechanical and Physical Properties of woven polypropylene Separation Fabric Geotextile:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Grab Tensile Strength	ASTM D 4632	Pounds	200
Grab Elongation (Max percent)	ASTM D 4632	Percent (%)	15
Trapezoidal Tear	ASTM D 4533	Pounds	75
Puncture	ASTM D 6241	Pounds	700
Permittivity	ASTM D 4491	Sec-1	0.05
Flow Rate	ASTM D 4491	gal/min/ft2	4
Apparent Opening Size (Maximum)	ASTM D 4751	(U.S. Sieve)	40
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	70

**2.5 CALCIUM CHLORIDE**

- A. Calcium chloride shall conform to the requirements of AASHTO M 144. Either regular flake calcium chloride, Type 1, or concentrated flake, pellet or other granular calcium chloride, Type 2, may be used.

**2.6 WATER**

- A. All water used shall be clean and free of harmful amounts of oil, salt, acids, alkalis, sugar, organic matter, and other substances incurious to the finished product, plant life, or the establishment of vegetation.

**2.7 STONE**

- A. Refer to Division 31 Section "Earth Moving" for additional information.

**2.8 SEEDING**

- A. Permanent Seeding: Refer to Division 32 Section "Turfs and Grasses" for additional information.
- B. Temporary Seeding: Refer to the latest revision of the local and state guidelines for soil erosion and sediment control for additional information.

**2.9 INLET PROTECTION**

- A. Manufactured catch basin insert of woven polypropylene geotextile with integral lifting loops or straps conforming to the following:
- B. Mechanical and Physical Properties of Catch Basin Insert:

Mechanical Properties	Test Method	Unit	Minimum Average Roll Value
Grab Tensile Strength	ASTM D 4632	Pounds	350
Grab Elongation (Max percent)	ASTM D 4632	Percent (%)	30
Trapezoidal Tear	ASTM D 4533	Pounds	120
Puncture	ASTM D 4833	Pounds	140
Mullen Burst	ASTM D 3786	psi	600
Permittivity	ASTM D 4491	gal/min/sq ft	0.3
Flow Rate	ASTM D 4491	gal/min/ft2	150
Apparent Opening Size	ASTM D 4751	(U.S. Sieve)	40
UV Resistance (at 500 hours)	ASTM D 4355	% strength retained	90

Note: Catch basin inserts for catch basins with curb openings shall be equipped with integral curb deflector.

**2.10 COMPOST FILTER SOCKS**

- A. Woven silt tubular sediment control and stormwater runoff filtration device typically used for perimeter control of sediment and soluble pollutants as manufactured by Filtrexx, Friendly Environment, Pollution Solution Inc.

**2.11 CONSTRUCTION ENTRANCE**

- A. A stabilized pad of crushed stone located at any point where traffic will be entering or leaving the construction site to or from a public right-of-way or street or as shown on the drawings shall be constructed for the purpose of preventing the tracking of sediments onto public rights-of-way.
- B. Design Criteria:
  - 1. Use 1 1/2 to 2 1/2 inch diameter stone.
  - 2. Use an 8 inch layer of stone.
  - 3. Stone pad shall be full width of entrance.
- C. Minimum length shall be 40 feet, unless shown otherwise or authorized by the Engineer.

**PART 3 - EXECUTION**

**3.1 ADDITIONAL INFORMATION AND REQUIREMENTS**

- A. Refer to the soil erosion and sediment control narrative and specification on the Contract Drawings for additional information and requirements.

**3.2 EROSION CONTROL BLANKETS**

- A. Erosion control blankets shall be placed where indicated on the Contract Drawings, where directed by the erosion control supervisor and as required to adhere to the latest revision of the local and state guidelines for soil erosion and sediment control.
- B. Erosion control blankets shall also be placed on all exposed cut/fill slopes to protect against rainfall, in areas where seed and mulch will not stay in place alone and where seeding is outside the growing season.
- C. Grade and smooth the slope to provide good adhesion to soil surface.
- D. When erosion control blankets are installed to enhance plant growth, apply fertilizer, lime, and seed prior to placing blankets.
- E. Anchor erosion control blankets as recommended by the erosion control blanket manufacturer.
- F. When no longer required, as determined by the Engineer, temporary erosion control mats shall become the property of the Contractor and be removed and properly disposed.
- G. Ground disturbances, including holes and depressions caused by the installation and removal of the temporary erosion control blanket shall be backfilled and repaired.

**3.3 FILTER FABRIC**

- A. Sanitary Trench:
  - 1. Install filter fabric as required for installation of the sanitary pipe. Refer to the detail on the contract documents for additional information.

**3.4 SILT FENCE**

- A. Install silt fence as indicated on the Contract Drawings and per the latest revision of the local and state guidelines for soil erosion and sediment control. When two sections adjoin each other, they shall be overlapped by 6 inches, folded and stapled.
- B. All stockpile material (topsoil, borrow, etc.) shall have a silt fence constructed around the perimeter. Topsoil stockpiles left in place for a greater than 14 days shall be temporarily seeded to minimize erosion of the soil constituents and release of soluble nutrients. During windy conditions, stockpiled material shall be covered or watered appropriately to prevent wind erosion.

**3.5 SEPARATION FABRIC**

- A. Install as indicated on the Contract Drawings.

**3.6 CALCIUM CHLORIDE**

- A. Control dust through the application of calcium chloride or water. An average application of one pound of calcium chloride per square yard of exposed area should be considered for each treatment. The exact number of applications and amount of dust control shall be based upon field and weather conditions. It shall be spread in such a manner and with such devices so that uniform distribution is attained. Calcium chloride shall not be applied within 50 feet of a stream bank or wetland.

**3.7 CATCH BASIN INLET PROTECTION**

- A. Install catch basin inlet sediment control devices in each exiting catch basin as long as it remains in use in accordance with manufacturer's guidelines at the locations shown on the Drawings.

- B. A catch basin sediment filter shall be installed and changed/cleaned per the manufacturer's recommendations, or as directed by the Engineer or Architect, during construction.
- C. New catch basins shall have a filter installed immediately upon completion of construction. In addition, a hay bale, or similar, barrier shall be installed around the new basin and maintained in place until binder is placed or disturbed areas draining to it are stabilized.
- D. Catch basins with curb openings shall have filter fabric covering the opening and the edges of the fabric shall be secured. A filter boom shall also be placed over the opening.

**3.8 COMPOST FILTER SOCK**

- A. Install as indicated on the Contract Drawings per the manufacturer's requirements.

**3.9 TEMPORARY MULCHING**

- A. Apply temporary mulch to areas where rough grading has been completed but final grading is not anticipated to begin within 30 calendar days of the completion of rough grading or where final grading has been completed but seeding is not anticipated for 20 days.
  - 1. Straw/Hay Mulch
    - a. Exposure Period: 6 months
    - b. Application Method: By hand or machine
    - c. Application Rate: 110 lbs/1,000 square feet.
  - 2. Bark Chips/Shredded Bark
    - a. Exposure Period: Less than one year
    - b. Application Method: By hand or machine
    - c. Application Rate: 6 cubic yards /1,000 square feet.

**3.10 CONSTRUCTION ENTRANCE**

- A. A stabilized pad of crushed stone located at any point where traffic will be entering or leaving the construction site to or from a public right-of-way or street or as shown on the drawings shall be constructed for the purpose of preventing the tracking of sediments onto public rights-of-way.

**3.11 RESTORATION**

- A. As soon as construction is completed in a given area, it shall be top-soiled, seeded, fertilized and/or mulched as specified on the drawings and in Part 2 and 3 of this Specification.
- B. The responsibility for satisfactory results on the work carried out under this item rests on the Contractor regardless of the prior approval of materials and methods on the part of the Engineer. The Contractor shall maintain the restored areas until such time as the work is accepted by the Owner. Maintenance shall include all regarding, refertilizing, reseeding, remulching, etc., which may be necessary in the opinion of the Owner and the Engineer.

**END OF SECTION 31 20 05**  
07/10/2018

**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. State of Connecticut Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form 817.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Hot-mix asphalt patching.
  - 2. Hot-mix asphalt paving.
  - 3. Pavement-marking paint.
  - 4. Hot-mix asphalt curbs.

**1.3 DEFINITION**

- A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
  - 1. Include technical data and tested physical and performance properties.
  - 2. Job-Mix Designs: For each job mix proposed for the Work.
  - 3. Traffic marking paint.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified manufacturer and Installer.
- B. Material Certificates: For each paving material, from manufacturer.

**1.6 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which 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 all governing authorities for asphalt paving work.
  - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.
- D. Preinstallation Conference: Conduct conference at Project site.



1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
  - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
  - b. Review condition of subgrade and preparatory work.
  - c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of 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 DELIVERY, STORAGE, AND HANDLING**

- A. Deliver pavement-marking materials to 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 temperature range required by manufacturer. Protect stored materials from direct sunlight.

#### **1.8 PROJECT CONDITIONS**

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for 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 time of placement.
  5. Asphalt Surface Course: Minimum surface temperature of 60 deg F at time of placement.
- B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and in accordance with the manufacturers requirements.

### **PART 2 - PRODUCTS**

#### **2.1 AGGREGATES**

- A. General: Use materials and gradations that have performed satisfactorily in previous installations.
- B. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.
- C. Fine Aggregate: AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.
  1. For hot-mix asphalt, limit natural sand to a maximum of 20 percent by weight of the total aggregate mass.

#### **2.2 ASPHALT MATERIALS**

- A. Asphalt Binder: AASHTO M 332, performance grade as required by state DOT specifications where the project is located.
- B. Prime Coat: Asphalt emulsion prime coat complying with state DOT specifications where project is located.

- C. Tack Coat: ASTM D 977 emulsified asphalt, or ASTM D 2397 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application. Verify acceptance with state DOT where the project is located.
- D. Water: Potable.
- E. Undersealing Asphalt: ASTM D 3141, pumping consistency.

### **2.3 AUXILIARY MATERIALS**

- A. Sand: ASTM D 1073, Grade Nos. 2 or 3.
- B. Pavement-Marking Paint:
  - 1. Waterborne pavement marking paint complying with state DOT where the project is located.
    - a. Color: As indicated in the Contract Documents.

### **2.4 MIXES**

- A. Hot-Mix Asphalt: AASHTO M 323 Superpave, dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction and complying with the following requirements:
  - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
  - 2. Surface Binder Course: Per state DOT where the project is located. Refer to drawings for additional information.
  - 3. Surface Wearing Course: Per state DOT where the project is located. Refer to drawings for additional information.
- B. Emulsified-Asphalt Slurry: ASTM D 3910, Type 1.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment 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.
  - 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 Engineer, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

### **3.2 PATCHING**

- A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.
- B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving 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.
- C. Patching: 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 SURFACE PREPARATION**

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.
1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
  2. Protect primed substrate from damage until ready to receive paving.
- C. 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.

### **3.4 HOT-MIX ASPHALT PLACING**

- A. Machine place hot-mix asphalt on 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 hot-mix asphalt base course in number of lifts and thicknesses as specified by the state DOT where the project is located.
  2. Place hot-mix asphalt surface course in number of lifts and thicknesses as specified by the state DOT where the project is located.
  3. Spread mix at minimum temperature of 250 deg F.
  4. Begin applying mix along centerline of crown for crowned sections and on 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 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 first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.
- C. Promptly correct surface irregularities in paving course behind 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.

### **3.5 JOINTS**

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
1. Clean contact surfaces and apply 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.

### 3.6 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 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: Each course placed at a depth of 1-1/2 inches or greater shall have the mat and longitudinal joints compacted to a minimum of 92.0 percent and no more than 97.0 percent density as determined by AASHTO T209 (modified).
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While 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 pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

### 3.7 ASPHALT CURBS

- A. Construct hot-mix asphalt curbs over compacted pavement surfaces. Apply a light tack coat unless pavement surface is still tacky and free from dust. Spread mix at minimum temperature of 250 deg F.
  1. Asphalt Mix: Per state DOT where the project is located. Refer to drawings for additional information.
- B. Place hot-mix asphalt to curb cross section indicated or, if not indicated, to local standard shapes, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

### 3.8 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
  1. Surface Binder Course: Plus or minus 1/2 inch.
  2. Surface Wearing 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. Surface Binder Course: 1/4 inch.
  - 2. Surface Wearing Course: 1/8 inch.
  - 3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

**3.9 PAVEMENT MARKING**

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect and/or Engineer.
- B. Allow paving to age for as recommended by pavement marking manufacturer before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness as recommended by pavement marking manufacturer.

**3.10 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- C. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- D. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- E. In-Place Density: Field density of in-place compacted pavement shall be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- F. In-Place Density: Field density of in-place compacted pavement may also be determined by testing agency taking samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979.
  - 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. 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.
- G. Replace and compact hot-mix asphalt where core tests were taken.
- H. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

**3.11 DISPOSAL**

- A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

**3.12 AS-BUILT DRAWINGS**

- A. The Contractor shall provide as-built drawings markups on a monthly basis. As work progresses, all construction activities shall be documented. The record documents shall include:
  - 1. Location and extend of curbs, pavements, wheel stops, traffic calming devices.
  - 2. The Contractor shall hire the services of a surveyor licensed in the state where the work is being performed to determine parameters stated above or completed work and record the results and update the electronic files. As-builts shall include horizontal and vertical locations (elevations) at 50-foot increments.
  - 3. Final documents (drawings and electronic files in AutoCAD format, latest edition), shall be submitted to the designated Owner's Representative not later than 30 days after substantial completion of the project. All comments shall be incorporated to the final documents within 14 days after receiving them from the Owner's Representative. The final record set (hard copy and the electronic files) shall be submitted to the Owner's Representative.

**END OF SECTION 32 12 16**  
07/10/2018

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**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. State of Connecticut Department of Transportation, Standard Specifications for Roads, Bridges, Facilities and Incidental Construction, Form 817.

**1.2 SUMMARY**

- A. Section Includes:
  - 1. Chain-link fences.
  - 2. Gates: Swing.
- B. Related Sections:
  - 1. Section 033100 "Site Cast-in-Place Concrete" for cast-in-place concrete.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Delegated Design: Design chain-link fences and gates, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Chain-link fence and gate framework shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated according to ASCE/SEI 7:
  - 1. Minimum Post Size: Determine according to ASTM F 1043 for framework, height required to cover selected mechanical equipment and meet equipment clearance requirements, and post spacing not to exceed 10 feet for 1A, ASTM F 1043, Schedule 40 Steel Pipe.
  - 2. Gate Height: Refer to Contract Documents.
  - 3. Enclosure Height: Refer to Contract Documents.
  - 4. Chain link fence enclosures around mechanical equipment shall include a top "roof" in addition to the walls and gates.
  - 5. Chain link fence walls shall be designed with openings to allow for mechanical equipment ductwork/piping to pass through. Refer to contract documents for additional information.
- C. Lightning Protection System: Maximum grounding-resistance value of 25 ohms under normal dry conditions.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for chain-link fences and gates.
  - 1. Fence and gate posts, rails, and fittings.
  - 2. Chain-link fabric, reinforcements, and attachments.
  - 3. Gates and hardware.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work. Show accessories, hardware, gate operation, and operational clearances.
- C. Samples for Initial Selection: For components with factory-applied color finishes.



- D. Samples for Verification: Prepared on Samples of size indicated below:
  - 1. Polymer-Coated Components: In 6-inch lengths for components and on full-sized units for accessories.
- E. Delegated-Design Submittal: For chain-link fences and gate framework indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

**1.5 INFORMATIONAL SUBMITTALS**

- A. Qualification Data: For qualified professional engineer, testing agency and factory-authorized service representative.
- B. Product Certificates: For each type of chain-link fence and gate, from manufacturer.
- C. Product Test Reports: For framing strength according to ASTM F 1043.
- D. Field quality-control reports.
- E. Warranty: Sample of special warranty.

**1.6 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For the following to include in emergency, operation, and maintenance manuals:
  - 1. Polymer finishes.
  - 2. Gate hardware.

**1.7 QUALITY ASSURANCE**

- A. Testing Agency Qualifications: For testing fence grounding. Member company of NETA or an NRTL.
  - 1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

**1.8 PROJECT CONDITIONS**

- A. Field Measurements: Verify layout information for chain-link fences and gates shown on Drawings in relation to property survey and existing structures. Verify dimensions by field measurements.

**PART 2 - PRODUCTS**

**2.1 CHAIN-LINK FENCE FABRIC**

- A. General: Provide fabric in one-piece heights measured between top and bottom of outer edge of selvage knuckle or twist. Comply with CLFMI Product Manual and with requirements indicated below:
  - 1. Fabric Height: As determined in delegated design or as indicated on Drawings. Refer to paragraph 1.3 for additional performance requirements.
  - 2. Steel Wire Fabric: Wire with a diameter of 0.1495 inch.
    - a. Mesh Size: 2 inches.
    - b. Zinc-Coated Fabric: ASTM A 392, Type II, Class 2, 2.0 oz./sq. ft. with zinc coating applied before weaving.

**2.2 FENCE FRAMING**

- A. Posts and Rails: Comply with ASTM F 1043 for framing, including rails, braces, and line; terminal; and corner posts. Provide members with minimum dimensions and wall thickness according to ASTM F 1043 and ASTM F 1083 based on the following:
  - 1. Fence Height: As determined in delegated design or as indicated on Drawings. Refer to paragraph 1.3 for additional performance requirements.
  - 2. Horizontal Framework Members: Intermediate, top and bottom rails complying with ASTM F 1043.
  - 3. Metallic Coating for Steel Framing:
    - a. Type A, consisting of not less than minimum 2.0-oz./sq. ft. average zinc coating per ASTM A 123/A 123M or 4.0-oz./sq. ft. zinc coating per ASTM A 653/A 653M.

**2.3 SWING GATES**

- A. General: Comply with ASTM F 900 for gate posts and single swing gate types.
  - 1. Gate Leaf Width: As indicated on Contract Documents.
  - 2. Gate Fabric Height: As indicated on Contract Documents.
- B. Pipe and Tubing:
  - 1. Zinc-Coated Steel: Comply with ASTM F 1043 and ASTM F 1083; protective coating and finish to match fence framing.
  - 2. Gate Posts: Round tubular steel.
  - 3. Gate Frames and Bracing: Round tubular steel.
- C. Frame Corner Construction: Assembled with corner fittings.
- D. Hardware:
  - 1. Hinges: 180-degree outward swing.
  - 2. Latches permitting operation from both sides of gate with provision for padlocking accessible from both sides of gate.
  - 3. Padlock and Chain: Owner to furnish padlocks and chains.
  - 4. Closer: Manufacturer's standard.

**2.4 FITTINGS**

- A. General: Comply with ASTM F 626.
- B. Post Caps: Provide for each post.
  - 1. Provide line post caps with loop to receive tension wire or top rail.
- C. Rail and Brace Ends: For each gate, corner, pull, and end post.
- D. Rail Fittings: Provide the following:
  - 1. Top Rail Sleeves: Round-steel tubing not less than 6 inches long.
  - 2. Rail Clamps: Line and corner boulevard clamps for connecting intermediate and bottom rails in the fence line-to-line posts.
- E. Tension and Brace Bands: Pressed steel.

- F. Tension Bars: Steel, length not less than 2 inches shorter than full height of chain-link fabric. Provide one bar for each gate and end post, and two for each corner and pull post, unless fabric is integrally woven into post.
- G. Truss Rod Assemblies: Steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.
- H. Tie Wires, Clips, and Fasteners: According to ASTM F 626.
  - 1. Standard Round Wire Ties: For attaching chain-link fabric to posts, rails, and frames, complying with the following:
    - a. Hot-Dip Galvanized Steel: 0.148-inch diameter wire; galvanized coating thickness matching coating thickness of chain-link fence fabric.
- I. Finish:
  - 1. Metallic Coating for Pressed Steel or Cast Iron: Not less than 1.2 oz. /sq. ft. zinc.
    - a. Polymer coating over metallic coating.

**2.5 CAST-IN-PLACE CONCRETE**

- A. General: Refer to Division 03.

**2.6 GROUT AND ANCHORING CEMENT**

- A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout, recommended in writing by manufacturer, for exterior applications.

**2.7 FENCE GROUNDING**

- A. Conductors: Bare, solid wire for No. 6 AWG and smaller; stranded wire for No. 4 AWG and larger.
  - 1. Material above Finished Grade: Aluminum.
  - 2. Material on or below Finished Grade: Copper.
  - 3. Bonding Jumpers: Braided copper tape, 1 inch wide, woven of No. 30 AWG bare copper wire, terminated with copper ferrules.
- B. Connectors and Grounding Rods: Comply with UL 467.
  - 1. Connectors for Below-Grade Use: Exothermic welded type.
  - 2. Grounding Rods: Copper-clad steel, 5/8 by 96 inches.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

- A. Examine areas and conditions, with Installer present, for compliance with requirements for a verified survey of property lines and legal boundaries, site clearing, earthwork, pavement work, and other conditions affecting performance of the Work.
  - 1. Do not begin installation before final grading is completed unless otherwise permitted by Architect.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

- A. Stake locations of fence lines, gates, and terminal posts. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

**3.3 INSTALLATION, GENERAL**

- A. Install chain-link fencing to comply with ASTM F 567.

**3.4 CHAIN-LINK FENCE INSTALLATION**

- A. Post Excavation: Drill or hand-excavate holes for posts to diameters and spacings indicated, in firm, undisturbed soil.
- B. Post Setting: Set posts in concrete at indicated spacing into firm, undisturbed soil.
  - 1. Verify that posts are set plumb, aligned, and at correct height and spacing, and hold in position during setting with concrete or mechanical devices.
  - 2. Concrete Fill: Place concrete around posts to dimensions indicated and vibrate or tamp for consolidation. Protect aboveground portion of posts from concrete splatter.
    - a. Concealed Concrete: Top 2 inches below grade as indicated on Drawings to allow covering with surface material.
    - b. Posts Set into Concrete in Sleeves: Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
    - c. Posts Set into Voids in Concrete: Form or core drill holes not less than 5 inches deep and 3/4 inch larger than OD of post. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout, mixed and placed to comply with anchoring material manufacturer's written instructions, and finished sloped to drain water away from post.
- C. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F 567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.
- D. Line Posts: Space line posts uniformly at 10 feet o.c.
- E. Post Bracing and Intermediate Rails: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Diagonally brace terminal posts to adjacent line posts with truss rods and turnbuckles. Install braces at end and gate posts and at both sides of corner and pull posts.
  - 1. Locate horizontal braces at midheight of fabric 72 inches or higher, on fences with top rail and at two-third fabric height on fences without top rail. Install so posts are plumb when diagonal rod is under proper tension.
- F. Tension Wire: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with 0.120-inch- diameter hog rings of same material and finish as fabric wire, spaced a maximum of 24 inches o.c. Install tension wire in locations indicated before stretching fabric. Provide horizontal tension wire at the following locations:
  - 1. Extended along top and bottom of fence fabric. Install top tension wire through post cap loops. Install bottom tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.
  - 2. As indicated.
- G. Top Rail: Install according to ASTM F 567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps, bending to radius for curved runs and terminating into rail end

attached to posts or post caps fabricated to receive rail at terminal posts. Provide expansion couplings as recommended in writing by fencing manufacturer.

- H. Intermediate and Bottom Rails: Install and secure to posts with fittings.
- I. Chain-Link Fabric: Apply fabric to outside of enclosing framework. Leave 1 inch between finish grade or surface and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.
- J. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches o.c.
- K. Tie Wires: Use wire of proper length to firmly secure fabric to line posts and rails. Attach wire at one end to chain-link fabric, wrap wire around post a minimum of 180 degrees, and attach other end to chain-link fabric per ASTM F 626. Bend ends of wire to minimize hazard to individuals and clothing.
  - 1. Maximum Spacing: Tie fabric to line posts at 12 inches o.c. and to braces at 24 inches o.c.
- L. Fasteners: Install nuts for tension bands and carriage bolts on the side of the fence opposite the fabric side.

### **3.5 GATE INSTALLATION**

- A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach fabric as for fencing. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

### **3.6 GROUNDING AND BONDING**

- A. Fence Grounding: Install at maximum intervals of 1500 feet except as follows:
  - 1. Fences within 100 Feet of Buildings, Structures, Walkways, and Roadways: Ground at maximum intervals of 750 feet.
    - a. Gates and Other Fence Openings: Ground fence on each side of opening.
      - 1) Bond metal gates to gate posts.
      - 2) Bond across openings, with and without gates, except openings indicated as intentional fence discontinuities. Use No. 2 AWG wire and bury it at least 18 inches below finished grade.
- B. Protection at Crossings of Overhead Electrical Power Lines: Ground fence at location of crossing and at a maximum distance of 150 feet on each side of crossing.
- C. Fences Enclosing Electrical Power Distribution Equipment: Ground as required by IEEE C2 unless otherwise indicated.
- D. Grounding Method: At each grounding location, drive a grounding rod vertically until the top is 6 inches below finished grade. Connect rod to fence with No. 6 AWG conductor. Connect conductor to each fence component at the grounding location, including the following:
  - 1. Make grounding connections to each barbed wire strand with wire-to-wire connectors designed for this purpose.
  - 2. Make grounding connections to each barbed tape coil with connectors designed for this purpose.
- E. Bonding Method for Gates: Connect bonding jumper between gate post and gate frame.

- F. Connections: Make connections to minimize possibility of galvanic action or electrolysis. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
  2. Make connections with clean, bare metal at points of contact.
  3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  4. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
  5. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- G. Bonding to Lightning Protection System: If fence terminates at lightning-protected building or structure, ground the fence and bond the fence grounding conductor to lightning protection down conductor or lightning protection grounding conductor complying with NFPA 780.

### **3.7 FIELD QUALITY CONTROL**

- A. Grounding-Resistance Testing: Engage a qualified testing agency to perform tests and inspections.
1. Grounding-Resistance Tests: Subject completed grounding system to a megger test at each grounding location. Measure grounding resistance no fewer than two full days after last trace of precipitation, without soil having been moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural grounding resistance. Perform tests by two-point method according to IEEE 81.
  2. Excessive Grounding Resistance: If resistance to grounding exceeds specified value, notify Architect promptly. Include recommendations for reducing grounding resistance and a proposal to accomplish recommended work.
  3. Report: Prepare test reports certified by a testing agency of grounding resistance at each test location. Include observations of weather and other phenomena that may affect test results.

### **3.8 ADJUSTING**

- A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.
- B. Lubricate hardware and other moving parts.

### **3.9 DEMONSTRATION**

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain chain-link fences and gates.

### **3.10 AS-BUILT DRAWINGS**

- A. The Contractor shall provide as-built drawings including as-built ties and markups on a monthly basis. As work progresses, all construction activities shall be documented. The record documents shall include:
1. Location, elevation, and type (size and quantity) of installed fence components. Location, elevation, and type of existing exposed utilities during installation of new work, vaults, manholes, transformers, valves, above- and belowground conduits, walls, bridges, signs, fences, structural fill, and any other surface and subsurface elements as defined in the specifications.
  2. The Contractor shall hire the services of a surveyor licensed in the state where the work is being performed to determine parameters stated above of completed work and record the results and update the electronic files. As-builts shall include lateral and vertical (depth) locations of all utilities at 50 foot increments as well as swing ties.
  3. Document installation with photographs in digital format, especially but not limited to, installation of fence footings, posts, gates and related fencing components.

4. Final documents (drawings and electronic files in AutoCAD format, latest edition), shall be submitted to the designated Owner's Representative not later than 30 days after substantial completion of the project. All comments shall be incorporated to the final documents within 14 days after receiving them from the Owner's Representative. The final record set (hard copy and electronic files) shall be submitted to the Owner's Representative.

**END OF SECTION 32 31 13**  
07/10/2018

**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. Turf renovation.
  - 3. Erosion-control material(s).
- B. Related Sections:
  - 1. Section 311000 "Site Clearing" for topsoil stripping and stockpiling.
  - 2. Section 312000 "Earth Moving" for excavation, filling and backfilling, and rough grading.

**1.3 DEFINITIONS**

- A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.
- B. Finish Grade: Elevation of finished surface of planting soil.
- C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.
- D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.
- E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.
- F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.
- G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.
- H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.
- I. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

**1.4 ACTION SUBMITTALS**

- A. Product Data: For each type of product indicated.



1. Pesticides and Herbicides: Include product label and manufacturer's application instructions specific to this Project.

**1.5 INFORMATIONAL SUBMITTALS**

- A. 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.
- B. Qualification Data: For qualified landscape Installer.
- C. Product Certificates: For soil amendments and fertilizers, from manufacturer.
- D. Material Test Reports: For standardized ASTM D 5268 topsoil, existing native surface topsoil, existing in-place surface soil and imported or manufactured topsoil.
- E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of turf during a calendar year. Submit before expiration of required initial maintenance periods.

**1.6 QUALITY ASSURANCE**

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
  1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
  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 personnel assigned to the Work shall have certification in one of the following categories from the Professional Landcare Network:
    - a. Certified Landscape Technician - Exterior, with installation, maintenance and irrigation specialty area(s), designated CLT-Exterior.
    - b. Certified Turfgrass Professional, designated CTP.
    - c. Certified Turfgrass Professional of Cool Season Lawns, designated CTP-CSL.
  5. Maintenance Proximity: Not more than two hours' normal travel time from Installer's place of business to Project site.
  6. Pesticide Applicator: State licensed, commercial.
- B. Soil-Testing Laboratory Qualifications: An independent laboratory or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.
- C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; sodium absorption ratio; deleterious material; pH; and mineral and plant-nutrient content of the soil.
  1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
  2. The soil-testing laboratory shall oversee soil sampling, with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
  3. Report suitability of tested soil for turf growth.
    - a. Based on the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. or volume per cu. yd.

for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.

- b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

### **1.7 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 conformance 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 fertilizers, lime, and soil amendments with appropriate certificates.

### **1.8 PROJECT 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. Refer to Part 2, Paragraph 2.1 SEED.
- 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.

### **1.9 MAINTENANCE SERVICE**

- A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. 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 Turf: 90 days 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.

## **PART 2 - PRODUCTS**

### **2.1 SEED**

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Seed Species: Seed of grass species as follows, with not less than 95 percent germination, not less than 85 percent pure seed, and not more than 0.5 percent weed seed:

1. Seeding done prior to May 1<sup>st</sup> and September 1<sup>st</sup> to October 31<sup>st</sup> shall comply with the following mixture:

Creeping Red Fescue	35 Parts
Chewings Red Fescue	20 Parts
Kentucky 31 Tall Fescue	15 Parts
Baron Bluegrass	20 Parts
Rough Bluegrass	10 Parts

Sow this mixture at the rate of 4 lbs. per 1,000 sq. ft.

2. Seeding done at any other time of the year (May 1<sup>st</sup> to September 1<sup>st</sup>) and all seeding of slopes shall comply with the following mixture:

Creeping Red Fescue	35 Parts
Chewings Red Fescue	20 Parts
Kentucky 31 Tall Fescue	20 Parts
Domestic Rye Grass	25 Parts

Sow this mixture at the rate of 6 lbs. per 1,000 sq. ft.

## **2.2 INORGANIC SOIL AMENDMENTS**

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 sieve and a minimum of 75 percent passing through No. 60 sieve.
2. Provide lime in form of ground dolomitic limestone.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 sieve and a maximum of 10 percent passing through No. 40 sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

**2.3 ORGANIC SOIL AMENDMENTS**

- A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
  - 1. Organic Matter Content: 50 to 60 percent of dry weight.
  - 2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.
- B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.
- C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.
  - 1. In lieu of decomposed wood derivatives, mix partially decomposed wood derivatives with ammonium nitrate at a minimum rate of 0.15 lb/cu. ft. of loose sawdust or ground bark, or with ammonium sulfate at a minimum rate of 0.25 lb/cu. ft. of loose sawdust or ground bark.
- E. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

**2.4 FERTILIZERS**

- A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 4 percent nitrogen and 10 percent phosphoric acid.
- B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.
- C. 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: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.
- D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
  - 2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

**2.5 PLANTING SOILS**

- A. Planting Soil: ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 10 percent organic material content; free of stones 1 inch or larger in any dimension and other extraneous materials harmful to plant growth.

- B. Planting Soil: Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
1. Supplement with imported planting soil when quantities are insufficient.
  2. Verify planting soil meets requirements in Paragraph A. Provide amendments as required to meet local standards.
- C. Planting Soil: Existing, in-place surface soil. Verify suitability of existing surface soil to produce viable planting soil. Remove stones, roots, plants, sod, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix surface soil with planting soil as described in Paragraph A. Provide amendments as required to meet local standards.
- D. Planting Soil: Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches deep; do not obtain from agricultural land, bogs or marshes.
1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, 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 harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and brome grass; not infested with nematodes, grubs, other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled, pore-space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.
  2. Mix imported topsoil or manufactured topsoil with planting soil as described in Paragraph 4. Provide amendments as required to meet local standards.

## **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. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.
- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.
- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:
1. Organic Matter Content: 50 to 60 percent of dry weight.
  2. Feedstock: Agricultural, food, or industrial residuals; biosolids; yard trimmings; or source-separated or compostable mixed solid waste.

## **2.7 PESTICIDES**

- A. General: Pesticide, registered and approved by 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 Non-Selective): 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 Non-Selective): Effective for controlling weed growth that has already germinated.

## **2.8 EROSION-CONTROL MATERIALS**

- A. Erosion-Control Blankets: Refer to Section 312005 "Sedimentation and Erosion Control" for more information.

## **PART 3 - EXECUTION**

### **3.1 EXAMINATION**

- A. Examine areas to be planted for compliance with requirements and other conditions affecting performance.
  - 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. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
  - 3. Suspend soil spreading, grading, and tilling 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 and which is too 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 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 TURF AREA PREPARATION**

- A. Limit turf subgrade preparation to areas to be planted.
- B. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches. Remove stones larger than 1 inch in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
  - 1. Apply fertilizer directly to subgrade before loosening.
  - 2. Thoroughly blend planting soil off-site before spreading or spread topsoil, apply soil amendments and fertilizer on surface, and thoroughly blend planting soil.
    - a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
    - b. Mix lime with dry soil before mixing fertilizer.
  - 3. Spread planting soil to a depth of 6 inches but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

- a. Spread approximately 1/2 the thickness of planting soil over loosened subgrade. Mix thoroughly into top 2 inches of subgrade. Spread remainder of planting soil.
- C. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:
  - 1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.
  - 2. Loosen surface soil to a depth of at least 8 inches. Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches of soil. Till soil to a homogeneous mixture of fine texture.
    - a. Apply fertilizer directly to surface soil before loosening.
  - 3. Remove stones larger than 1 inch in any dimension and sticks, roots, trash, and other extraneous matter.
  - 4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.
- D. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.
- E. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- F. Before planting, obtain Engineer's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### **3.4 PREPARATION FOR EROSION-CONTROL MATERIALS**

- A. Prepare area as specified in "Turf Area Preparation" Article.
- B. For erosion-control blanket or mesh, install from top of slope, working downward, and as recommended by material manufacturer for site conditions. Fasten as recommended by material manufacturer.
- C. Moisten prepared area before planting if surface is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

### **3.5 SEEDING**

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 1. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 2. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 5 to 8 lb/1000 sq. ft.
- C. Rake seed lightly into top 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 installed and stapled according to manufacturer's written instructions.
- E. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 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.

- F. Protect seeded areas from hot, dry weather or drying winds by applying planting soil within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

**3.6 TURF RENOVATION**

- A. Renovate existing turf.
- B. Renovate existing turf damaged by Contractor's operations, such as storage of materials or equipment and movement of vehicles.
  - 1. Reestablish turf where settlement or washouts occur or where minor regrading is required.
  - 2. Install new planting soil as required.
- C. Remove sod and vegetation from diseased or unsatisfactory turf areas; do not bury in soil.
- D. Remove topsoil containing foreign materials such as oil drippings, fuel spills, stones, gravel, and other construction materials resulting from Contractor's operations, and replace with new planting soil.
- E. Mow, dethatch, core aerate, and rake existing turf.
- F. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.
- G. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of them off Owner's property.
- H. Till stripped, bare, and compacted areas thoroughly to a soil depth of 6 inches.
- I. Apply soil amendments and initial fertilizers required for establishing new turf and mix thoroughly into top 4 inches of existing soil. Install new planting soil to fill low spots and meet finish grades.
- J. Apply seed and protect with straw mulch as required for new turf.
- K. Water newly planted areas and keep moist until new turf is established.

**3.7 TURF MAINTENANCE**

- A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, 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.
  - 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 turf with fine spray at a minimum rate of 1 inch per week unless rainfall precipitation is adequate.



- C. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain the following grass height:
  - 1. Mow perennial ryegrass to a height of 1 to 2 inches.
  - 2. Mow Kentucky bluegrass, annual ryegrass and chewings red fescue to a height of 1-1/2 to 2 inches.
  - 3. Mow turf-type tall fescue to a height of 2 to 3 inches.
- D. Turf Postfertilization: Apply fertilizer after initial mowing and when grass is dry.
  - 1. Use fertilizer that will provide actual nitrogen of at least 1 lb/1000 sq. ft. to turf area.

### **3.8 SATISFACTORY TURF**

- 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. and bare spots not exceeding 3 by 3 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

### **3.9 PESTICIDE APPLICATION**

- A. Apply pesticides and other chemical products and biological control agents in accordance with requirements of 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. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

### **3.10 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. 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.
- C. Remove nondegradable erosion-control measures after grass establishment period.

**END OF SECTION 32 92 00**  
07/10/2018

# **Section 50 30 00 Hazardous Building Materials Inspection and Inventory**

15-0425-11  
May 29, 2014



Rick Voelker, P.E.  
Principal  
Fletcher Thompson, Inc.  
855 Main Street, 8<sup>th</sup> Floor  
Bridgeport, CT 06601-1501

Re: **Hazardous Building Materials Inspection Report  
CTARNG Vision 2020 Project #8 (EN1301) Enfield Armory Renovations  
1635 King Street, Enfield, Connecticut**

Dear Mr. Voelker:

In accordance with our proposal dated October 9, 2013, Tighe & Bond has completed a Hazardous Building Materials Inspection (HBMI) for the hazardous materials storage shed at the Connecticut Army National Guard Property located at 1635 King Street in Enfield, CT (site). Based on the information you provided, this project involves demolition of the existing structure. The purpose of the inspection was to determine if hazardous building materials are associated with building components that will be impacted during proposed demolition activities.

## **Inspection Summary**

The HBMI was conducted by State of Connecticut licensed inspector, Justin Proto of Tighe & Bond on April 24, 2014. A copy of the inspector's license is included in Appendix A. The HBMI was limited to the materials slated to be impacted by proposed demolition activities associated with the HazMat shed. The inspection included sampling of suspect asbestos containing materials (ACM). Caulking was also sampled for analysis of polychlorinated biphenyls (PCBs). An evaluation of existing electrical equipment for asbestos containing materials, PCBs, DEHP, or other hazardous materials was conducted as part of the inspection.

## **Suspect Asbestos-Containing Material Sampling**

A total of 5 different types of suspect asbestos containing materials were observed and sampled during this inspection. Sampled materials are listed in Table 1 (Appendix B). Samples were collected of each suspect material in accordance with the United States Environmental Protection Agency (EPA) requirements for asbestos identification. Samples were submitted to EMSL Laboratories in Wallingford, Connecticut for asbestos analysis via Polarized Light Microscopy (PLM) using EPA approved protocol in accordance with accreditation of the National Institute of Standards and Technology (NIST).

During inspection activities the sample locations, types of material, and quantities were recorded. Homogenous materials were noted when observed.

## **PCB Sampling of Caulk Compounds**

Samples were collected of caulking compounds observed during the inspection. Two different types of caulks were observed. Samples of each different type of material were collected in accordance with the EPA sampling guidelines. These samples were submitted to Phoenix Laboratories for analysis of PCBs utilizing the EPA 3540C Soxhlet Extraction and SW 846 8082 analytical method.



## Findings and Conclusions

### Asbestos Sampling Results

During the course of the inspection, a total of 10 bulk samples of suspect ACM were collected and 10 samples were analyzed by PLM based on the “stop on first positive” request from the laboratory.

EPA defines any material containing more than 1% asbestos as ACM. None of the materials sampled were found to be ACM.

Refer to Table 1 for a summary of materials sampled and locations. Laboratory analytical reports for asbestos sampling are provided in Appendix C.

If additional materials are encountered during upgrade activities that were not previously sampled then they would need to be sampled to determine if it is an asbestos containing material or should be assumed to be asbestos containing.

All regulated friable and non-friable ACM must be removed prior to renovation or demolition activities. A State of Connecticut Licensed Asbestos Abatement Contractor must be retained to perform removal work. Visual inspections must be performed within each abatement area at the completion of the abatement work. The visual inspection must be performed by a State of Connecticut Licensed Asbestos Project Monitor. The abatement areas must meet final visual inspection criteria prior to renovation or demolition activities. Re-occupancy air monitoring is required before any entry of any person into the work area.

The Asbestos Abatement Contractor must submit a notice of asbestos abatement to the State of Connecticut Department of Health post marked or hand delivered 10 days prior to the commencement of any asbestos abatement activities involving the abatement of greater than 10 linear feet or 25 square feet of asbestos containing materials.

### PCB Sample Results for Caulk, Glazing Compounds

A total of six samples were submitted for analysis of PCBs (2 different types of materials). An interior door frame caulk and an exterior door frame caulk were the only suspect PCB containing materials identified. None of the sampled materials were found to contain PCBs in concentrations greater than 1 ppm.

Source materials containing PCBs at concentrations greater than 50 ppm are regulated by EPA and materials greater than 1 ppm by the Connecticut Department of Energy and Environmental Protection (CTDEEP). Materials with PCB concentrations less than or equal to 1 ppm are not regulated and can be disposed of as general construction waste. Refer to Table 2 for a detailed list of materials sampled for PCBs. Laboratory analytical reports for PCB sampling are provided in Appendix D.

### Visual Inspection for Universal Wastes

A visual inspection for lighting ballasts, transformers, electrical switches, small electrical motor capacitors and other items that could contain PCBs or DEHP was conducted. No universal wastes were identified within the HazMat shed.

If you have any questions regarding this letter report, please contact James Webb at (860)704-4783/[jtwebb@tighebond.com](mailto:jtwebb@tighebond.com) or James Olsen at (860)704-4761 [jtolsen@tighebond.com](mailto:jtolsen@tighebond.com).

Very truly yours,  
**TIGHE & BOND, INC.**

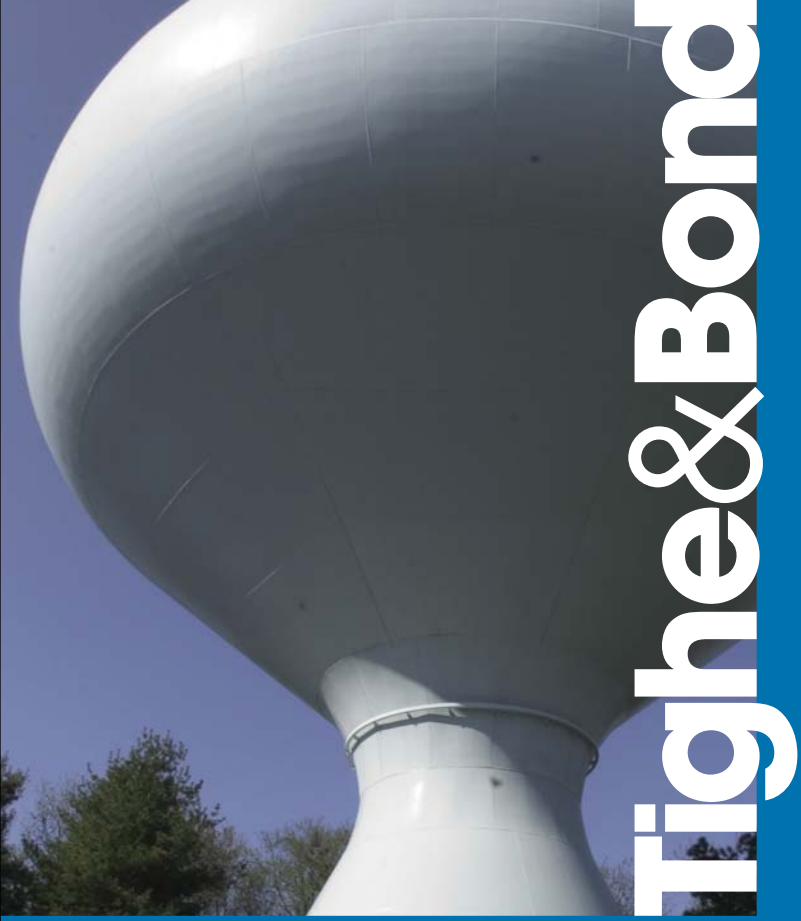


James Webb  
Project Environmental Compliance Specialist



James T. Olsen, LEP  
Vice President

Enclosures:   **Appendix A** - Inspector Licenses  
                  **Appendix B** - Table 1 Summary of Non-Asbestos Containing Materials  
                                  Table 2 Summary of PCB Sampling Results  
                  **Appendix C** - EMSL Asbestos Laboratory Analytical Reports  
                  **Appendix D** - Phoenix Laboratory Analytical Reports



# Tighe & Bond



# Tighe & Bond

Table 1  
 Summary of Non-Asbestos Containing Materials  
 Enfield Armory  
 Enfield, CT

Sampling Date: 4/24/2014

<b>Sample #</b>	<b>Material</b>	<b>Color</b>	<b>Description</b>	<b>Room</b>	<b>Result</b>
4-24 JP 01 & 02	CMU Mortar	Grey	Walls	Interior	None-Detected
4-24 JP 03 & 04	Interior Door Frame Caulk	White	Door Frame	Interior	None-Detected
4-24 JP 05 & 06	Top Layer Roofing	White/Black	Roofing	Exterior	None-Detected
4-24 JP 07 & 08	Bottom Layer Roofing	Grey/Black	Roofing	Exterior	None-Detected
4-24 JP 09 & 10	Exterior Door Frame Caulk	Grey	Door Frame	Exterior	None-Detected



TABLE 2  
Summary of PCB Sampling Results  
Enfield Armory  
Enfield, CT

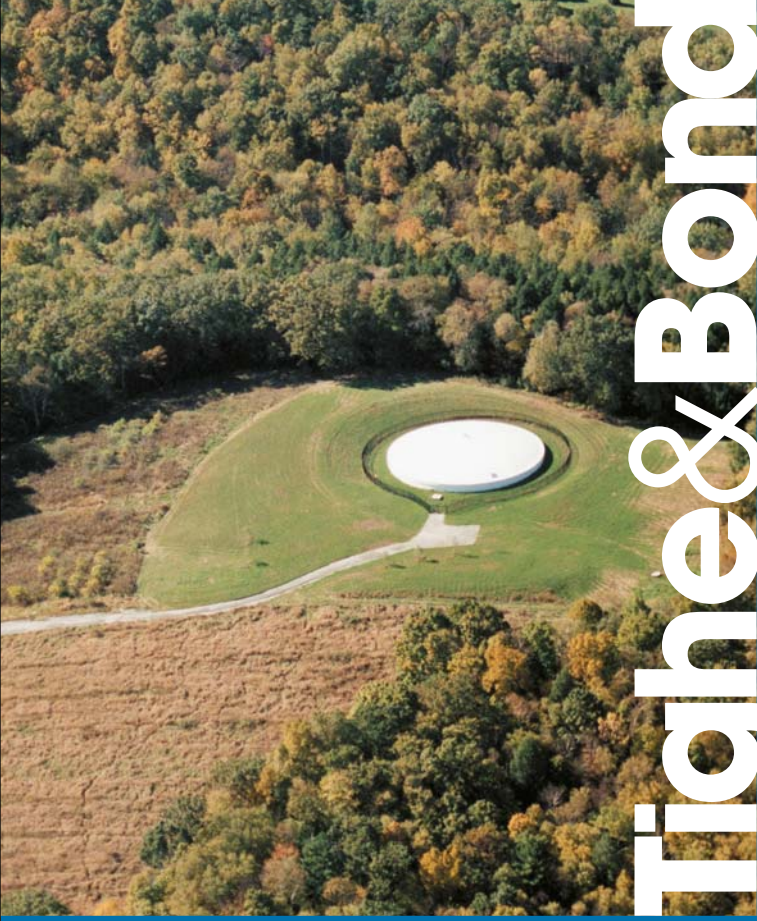
**PCB Sampling Date:** 4/24/2014

<b>Sample #</b>	<b>Description</b>	<b>Location</b>	<b>Result (ppm)</b>	<b>Notes</b>
4-24 PCB-01	Interior Door Frame Caulk	Interior	ND <0.78	Found at Interior Door frame
4-24 PCB-02	Interior Door Frame Caulk	Interior	ND <0.75	Found at Interior Door frame
4-24 PCB-03	Interior Door Frame Caulk	Interior	ND<0.41	Found at Interior Door frame
4-24 PCB-04	Exterior Door Frame Caulk	Exterior	ND<0.77	Found at Exterior Door frame
4-24 PCB-05	Exterior Door Frame Caulk	Exterior	ND<0.80	Found at Exterior Door frame
4-24 PCB-06	Exterior Door Frame Caulk	Exterior	ND<0.76	Found at Exterior Door frame

**LEGEND**

ppm = parts per million

ND = not detected above laboratory detection limits



# Tighe & Bond

**EMSL Analytical, Inc.**

29 North Plains Highway, Unit # 4, Wallingford, CT 06492

Phone/Fax: 203-284-5948 / (203) 284-5978

<http://www.EMSL.com>[wallingfordlab@emsl.com](mailto:wallingfordlab@emsl.com)

EMSL Order: 241401443

CustomerID: TIGH62

CustomerPO:

ProjectID:

Attn: **James Webb  
Tighe & Bond  
213 Court Street  
Suite 900  
Middletown, CT 06457**

Phone: (860) 704-4760  
Fax: (860) 704-4775  
Received: 04/24/14 3:45 PM  
Analysis Date: 5/1/2014  
Collected: 4/24/2014

Project: ENFIELD ARMORY

## Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
4-24 JP 01 241401443-0001	HAZ shed - CMU mortar	Gray Non-Fibrous Homogeneous	<1% Cellulose	25% Quartz 45% Ca Carbonate 30% Non-fibrous (other)	None Detected
4-24 JP 02 241401443-0002	HAZ shed - CMU mortar	Gray Non-Fibrous Homogeneous		20% Quartz 30% Ca Carbonate 50% Non-fibrous (other)	None Detected
4-24 JP 03 241401443-0003	HAZ shed - white door frame caulk	White Non-Fibrous Homogeneous	<1% Cellulose	25% Ca Carbonate 75% Non-fibrous (other)	None Detected
4-24 JP 04 241401443-0004	HAZ shed - white door frame caulk	White Non-Fibrous Homogeneous		100% Non-fibrous (other)	None Detected
4-24 JP 05 241401443-0005	HAZ shed - top layer roofing	White/Black Fibrous Homogeneous	60% Cellulose	20% Ca Carbonate 20% Non-fibrous (other)	None Detected
4-24 JP 06 241401443-0006	HAZ shed - top layer roofing	Black Non-Fibrous Homogeneous	45% Cellulose	55% Non-fibrous (other)	None Detected
4-24 JP 07 241401443-0007	HAZ shed - bottom layer roofing	Gray/Black Fibrous Homogeneous	25% Cellulose	75% Non-fibrous (other)	None Detected
4-24 JP 08 241401443-0008	HAZ shed - bottom layer roofing	Gray/Black Fibrous Homogeneous	35% Cellulose	65% Non-fibrous (other)	None Detected

Analyst(s)

Kristin Lopez (5)

William Shedrawy (2)

Renaldo Drakes (3)

Gloria V. Oriol, Laboratory Manager  
or other approved signatory

EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. Non-friable organically bound materials present a problem matrix and therefore EMSL recommends gravimetric reduction prior to analysis. Samples received in good condition unless otherwise noted. Estimated accuracy, precision and uncertainty data available upon request. Unless requested by the client, building materials manufactured with multiple layers (i.e. linoleum, wallboard, etc.) are reported as a single sample. Reporting limit is 1%

Samples analyzed by EMSL Analytical, Inc. Wallingford, CT NVLAP Lab Code 200700-0.

Initial report from 05/01/2014 19:18:34



# EMSL Analytical, Inc.

29 North Plains Highway, Unit # 4, Wallingford, CT 06492  
Phone/Fax: 203-284-5948 / (203) 284-5978  
<http://www.EMSL.com> [wallingfordlab@emsl.com](mailto:wallingfordlab@emsl.com)

EMSL Order: 241401443  
CustomerID: TIGH62  
CustomerPO:  
ProjectID:

Attn: **James Webb  
Tighe & Bond  
213 Court Street  
Suite 900  
Middletown, CT 06457**  
Project: ENFIELD ARMORY

Phone: (860) 704-4760  
Fax: (860) 704-4775  
Received: 04/24/14 3:45 PM  
Analysis Date: 5/1/2014  
Collected: 4/24/2014

## Test Report: Asbestos Analysis of Bulk Materials via EPA 600/R-93/116 Method using Polarized Light Microscopy

Sample	Description	Appearance	Non-Asbestos		Asbestos
			% Fibrous	% Non-Fibrous	% Type
4-24 JP 09 241401443-0009	Grey door frame caulk	Gray Non-Fibrous Homogeneous		25% Ca Carbonate 75% Non-fibrous (other)	None Detected
4-24 JP 10 241401443-0010	Grey door frame caulk	Gray Non-Fibrous Homogeneous		20% Ca Carbonate 80% Non-fibrous (other)	None Detected

Analyst(s) \_\_\_\_\_

Kristin Lopez (5) *William Shedrawy (2)*  
Renaldo Drakes (3)

Gloria V. Oriol, Laboratory Manager  
or other approved signatory

EMSL maintains liability limited to cost of analysis. This report relates only to the samples reported and may not be reproduced, except in full, without written approval by EMSL. EMSL bears no responsibility for sample collection activities or analytical method limitations. Interpretation and use of test results are the responsibility of the client. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST or any agency of the federal government. Non-friable organically bound materials present a problem matrix and therefore EMSL recommends gravimetric reduction prior to analysis. Samples received in good condition unless otherwise noted. Estimated accuracy, precision and uncertainty data available upon request. Unless requested by the client, building materials manufactured with multiple layers (i.e. linoleum, wallboard, etc.) are reported as a single sample. Reporting limit is 1%  
Samples analyzed by EMSL Analytical, Inc. Wallingford, CT NVLAP Lab Code 200700-0.

Initial report from 05/01/2014 19:18:34



# Tighe & Bond



Wednesday, April 30, 2014

Attn: Mr James Webb  
Tighe & Bond  
213 Court St  
Suite 900  
Middletown, CT 06457

Project ID: ENFIELD ARMORY  
Sample ID#s: BG37138 - BG37143

This laboratory is in compliance with the NELAC requirements of procedures used except where indicated.

This report contains results for the parameters tested, under the sampling conditions described on the Chain Of Custody, as received by the laboratory.

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

A scanned version of the COC form accompanies the analytical report and is an exact duplicate of the original.

If you have any questions concerning this testing, please do not hesitate to contact Phoenix Client Services at ext. 200.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Phyllis Shiller".

Phyllis Shiller  
Laboratory Director

NELAC - #NY11301  
CT Lab Registration #PH-0618  
MA Lab Registration #MA-CT-007  
ME Lab Registration #CT-007  
NH Lab Registration #213693-A,B

NJ Lab Registration #CT-003  
NY Lab Registration #11301  
PA Lab Registration #68-03530  
RI Lab Registration #63  
VT Lab Registration #VT11301



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37138

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-01 WHITE INT DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	780	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	780	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	86		%	04/28/14	AW	30 - 150 %
% TCMX	70		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

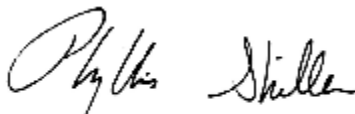
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

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**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**





Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37139

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-02 WHITE INT DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	750	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	750	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	96		%	04/28/14	AW	30 - 150 %
% TCMX	101		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

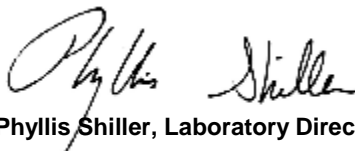
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

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**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37140

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-03 WHITE INT DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	410	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	410	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	78		%	04/28/14	AW	30 - 150 %
% TCMX	86		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
-----------	--------	------------	-------	-----------	----	-----------

RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

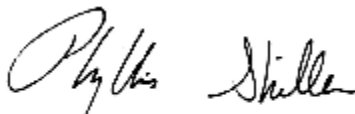
**Comments:**

100% Solid Assumed

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If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

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**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37141

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-04 GREY ING DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	770	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	770	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	117		%	04/28/14	AW	30 - 150 %
% TCMX	104		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
-----------	--------	------------	-------	-----------	----	-----------

RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

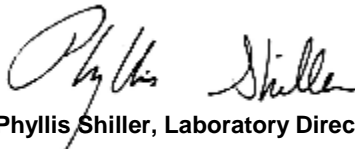
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

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**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37142

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-05 GREY EXT DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/29/14	AW	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	800	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	800	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	115		%	04/28/14	AW	30 - 150 %
% TCMX	104		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

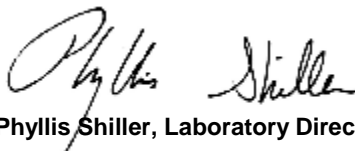
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

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**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**





Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# Analysis Report

April 30, 2014

FOR: Attn: Mr James Webb  
 Tighe & Bond  
 213 Court St  
 Suite 900  
 Middletown, CT 06457

Sample Information

Matrix: SOLID  
 Location Code: TIGHE  
 Rush Request: Standard  
 P.O.#:

Custody Information

Collected by:  
 Received by: LK  
 Analyzed by: see "By" below

Date

04/24/14  
 04/25/14

Time

0:00  
 14:46

## Laboratory Data

SDG ID: GBG37138  
 Phoenix ID: BG37143

Project ID: ENFIELD ARMORY  
 Client ID: 4-24-PCB-06 GREY DFC

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
Percent Solid	100		%	04/25/14	I	E160.3
Caulk Extraction for PCB	Completed			04/25/14	PP/X	SW3540C

**PCB (Soxhlet)**

PCB-1016	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1221	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1232	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1242	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1248	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1254	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1260	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1262	ND	760	ug/Kg	04/28/14	AW	3540C/8082
PCB-1268	ND	760	ug/Kg	04/28/14	AW	3540C/8082

**QA/QC Surrogates**

% DCBP	120		%	04/28/14	AW	30 - 150 %
% TCMX	108		%	04/28/14	AW	30 - 150 %

Parameter	Result	RL/ PQL	Units	Date/Time	By	Reference
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RL/PQL=Reporting/Practical Quantitation Level ND=Not Detected BRL=Below Reporting Level

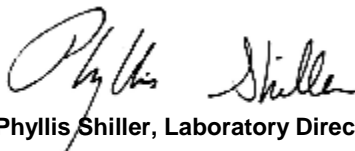
**Comments:**

100% Solid Assumed

All soils, solids and sludges are reported on a dry weight basis unless otherwise noted in the sample comments.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

This report must not be reproduced except in full as defined by the attached chain of custody.



**Phyllis Shiller, Laboratory Director**

**April 30, 2014**

**Reviewed and Released by: Greg Lawrence, Assistant Lab Director**



Environmental Laboratories, Inc.  
 587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
 Tel. (860) 645-1102 Fax (860) 645-0823

# QA/QC Report

April 30, 2014

## QA/QC Data

SDG I.D.: GBG37138

Parameter	Blank	LCS %	LCSD %	LCS RPD	MS %	MSD %	MS RPD	% Rec Limits	% RPD Limits
QA/QC Batch 272545, QC Sample No: BG36808 (BG37138, BG37139, BG37140, BG37141, BG37142, BG37143)									
<u>Polychlorinated Biphenyls - Solid</u>									
PCB-1016	ND	83	91	9.2				40 - 140	30
PCB-1221	ND							40 - 140	30
PCB-1232	ND							40 - 140	30
PCB-1242	ND							40 - 140	30
PCB-1248	ND							40 - 140	30
PCB-1254	ND							40 - 140	30
PCB-1260	ND	89	97	8.6				40 - 140	30
PCB-1262	ND							40 - 140	30
PCB-1268	ND							40 - 140	30
% DCBP (Surrogate Rec)	87	88	97	9.7				30 - 150	30
% TCMX (Surrogate Rec)	82	86	95	9.9				30 - 150	30

Comment:

The MS/MSD could not be reported due to matrix interference in the unspiked sample. LCS/LCSD recoveries were within QA/QC limits.

If there are any questions regarding this data, please call Phoenix Client Services at extension 200.

- RPD - Relative Percent Difference
- LCS - Laboratory Control Sample
- LCSD - Laboratory Control Sample Duplicate
- MS - Matrix Spike
- MS Dup - Matrix Spike Duplicate
- NC - No Criteria
- Intf - Interference

Phyllis Shiller, Laboratory Director  
 April 30, 2014

Criteria: None

State: CT

# Sample Criteria Exceedences Report

## GBG37138 - TIGHE

SampNo	Acode	Phoenix Analyte	Criteria	Result	RL	Criteria	RL Criteria	Analysis Units
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\*\*\* No Data to Display \*\*\*

Phoenix Laboratories does not assume responsibility for the data contained in this report. It is provided as an additional tool to identify requested criteria exceedences. All efforts are made to ensure the accuracy of the data (obtained from appropriate agencies). A lack of exceedence information does not necessarily suggest conformance to the criteria. It is ultimately the site professional's responsibility to determine appropriate compliance.

# Reasonable Confidence Protocol Laboratory Analysis QA/QC Certification Form

**Laboratory Name:** Phoenix Environmental Labs, Inc. **Client:** Tighe & Bond

**Project Location:** ENFIELD ARMORY **Project Number:**

**Laboratory Sample ID(s):** BG37138, BG37139, BG37140, BG37141, BG37142, BG37143

**Sampling Date(s):** 4/24/2014

**RCP Methods Used:**

- 1311/1312     6010     7000     7196     7470/7471     8081     EPH     TO15  
 8082     8151     8260     8270     ETPH     9010/9012     VPH

1.	For each analytical method referenced in this laboratory report package, were all specified QA/QC performance criteria followed, including the requirement to explain any criteria falling outside of acceptable guidelines, as specified in the CT DEP method-specific Reasonable Confidence Protocol documents?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
1a.	Were the method specified preservation and holding time requirements met?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
1b.	EPH and VPH methods only: Was the VPH or EPH method conducted without significant modifications (see section 11.3 of respective RCP methods)	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
2.	Were all samples received by the laboratory in a condition consistent with that described on the associated Chain-of-Custody document(s)?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
3.	Were samples received at an appropriate temperature (< 6 Degrees C)?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
4.	Were all QA/QC performance criteria specified in the Reasonable Confidence Protocol documents achieved?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No
5a.	Were reporting limits specified or referenced on the chain-of-custody?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No
5b.	Were these reporting limits met?	<input type="checkbox"/> Yes <input type="checkbox"/> No <input checked="" type="checkbox"/> NA
6.	For each analytical method referenced in this laboratory report package, were results reported for all constituents identified in the method-specific analyte lists presented in the Reasonable Confidence Protocol documents?	<input checked="" type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> NA
7.	Are project-specific matrix spikes and laboratory duplicates included in the data set?	<input type="checkbox"/> Yes <input checked="" type="checkbox"/> No <input type="checkbox"/> NA

**Note:** For all questions to which the response was "No" (with the exception of question #5a, #7), additional information must be provided in an attached narrative. If the answer to question #1, #1A or 1B is "No", the data package does not meet the requirements for "Reasonable Confidence".

**I, the undersigned, attest under the pains and penalties of perjury that, to the best of my knowledge and belief and based upon my personal inquiry of those responsible for providing the information contained in this analytical report, such information is accurate and complete.**

Authorized  
Signature:

Ethan Lee

Date: Wednesday, April 30, 2014

Printed Name: Ethan Lee

Position: Project Manager



**Environmental Laboratories, Inc.**  
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
Tel. (860) 645-1102 Fax (860) 645-0823



# RCP Certification Report

April 30, 2014

SDG ID.: GBG37138

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## PCB Narration

Were all QA/QC performance criteria specified in the Reasonable Confidence Protocol documents achieved? Yes.

**Instrument:** Au-ecd1 04/28/14-1 (BG37141, BG37142, BG37143)

8082 Narration:

The initial calibration RSD for the compound list was less than 15% except for the following compounds: none

The continuing calibration standards were within acceptance criteria except for the following compounds: none

**Printed Name** Adam Werner  
**Position:** Chemist  
**Date:** 4/28/2014

**Instrument:** Au-ecd3 04/28/14-1 (BG37139, BG37140)

8082 Narration:

The initial calibration RSD for the compound list was less than 15% except for the following compounds: none

The continuing calibration standards were within acceptance criteria except for the following compounds: none

**Printed Name** Adam Werner  
**Position:** Chemist  
**Date:** 4/28/2014

**Instrument:** Au-ecd5 04/28/14-1 (BG37138)

8082 Narration:

The initial calibration RSD for the compound list was less than 15% except for the following compounds: none

The continuing calibration standards were within acceptance criteria except for the following compounds: none

**Printed Name** Adam Werner  
**Position:** Chemist  
**Date:** 4/28/2014

**QC Comments:** QC Batch 272545 04/24/14 (BG37138, BG37139, BG37140, BG37141, BG37142, BG37143)

The MS/MSD could not be reported due to matrix interference in the unspiked sample. LCS/LCSD recoveries were within QA/QC limits.



**Environmental Laboratories, Inc.**  
587 East Middle Turnpike, P.O.Box 370, Manchester, CT 06045  
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# RCP Certification Report

April 30, 2014

SDG I.D.: GBG37138

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## QC (Batch Specific)

----- Sample No: BG36808, QA/QC Batch: 272545 -----

All LCS recoveries were within 40 - 140 with the following exceptions: None.

All LCSD recoveries were within 40 - 140 with the following exceptions: None.

All LCS/LCSD RPDs were less than 30% with the following exceptions: None.

## Temperature Narration

The samples were received at 6C with cooling initiated.  
(Note acceptance criteria is above freezing up to 6°C)

# CHAIN OF CUSTODY RECORD

587 East Middle Turnpike, P.O. Box 370, Manchester, CT 06040  
 Email: info@phoenixlabs.com Fax (860) 645-0823  
 Client Services (860) 645-8726



Customer: Tigne & Bond

Address: 213 Court St. Suite 900  
Middlesex, CT

Client Sample - Information - Identification  
 Sampler's Signature: [Signature] Date: 4-25-14

Matrix Code:  
 DW=Drinking Water GW=Ground Water SW=Surface Water WW=Waste Water  
 RW=Raw Water SE=Sediment SL=Sludge S=Soil SD=Solid W=Wipe  
 OIL=Oil B=Bulk L=Liquid

PHOENIX USE ONLY SAMPLE #	Customer Sample Identification	Sample Matrix	Date Sampled	Time Sampled
37138	4-24 PCB 01-	SD	4-24-14	AM
37139	White Ext. D.F.C.	SD		
37140	4-24 PCB 02-	SD		
37141	White Ext. D.F.C.	SD		
37142	4-24 PCB 03-	SD		
37143	White Ext. D.F.C.	SD		
	Gray Ext. D.F.C.	SD		
	4-24 PCB 04-	SD		
	Gray Ext. D.F.C.	SD		
	4-24 PCB 05-	SD		
	Gray Ext. D.F.C.	SD		
	4-24 PCB 06-	SD		
	Gray D.F.C.	SD		

Relinquished by: [Signature] Accepted by: [Signature]  
 Date: 4/25/14 Time: 1450  
4/25/14 14:40

Comments, Special Requirements or Regulations:  
 Turnaround:  
 1 Day  
 2 Days\*  
 3 Days\*  
 Standard  
 Other  
 \* SURCHARGE APPLIES \*

Analysis Request: SOLID PCBs

Analysis Request	RI	CT	MA	Data Format
	<input type="checkbox"/> Direct Exposure (Residential) <input type="checkbox"/> GW <input type="checkbox"/> Other	<input type="checkbox"/> RCP Cert <input type="checkbox"/> GW Protection <input type="checkbox"/> SW Protection <input type="checkbox"/> GA Mobility <input type="checkbox"/> GB Mobility <input type="checkbox"/> Residential DEC <input type="checkbox"/> I/C DEC <input type="checkbox"/> Other	<input type="checkbox"/> MCP Certification <input type="checkbox"/> GW-1 <input type="checkbox"/> GW-2 <input type="checkbox"/> GW-3 <input type="checkbox"/> S-1 <input type="checkbox"/> S-2 <input type="checkbox"/> S-3 <input type="checkbox"/> MWRA eSMART <input type="checkbox"/> Other	<input type="checkbox"/> Excel <input type="checkbox"/> PDF <input type="checkbox"/> GIS/Key <input type="checkbox"/> EQUIS <input type="checkbox"/> Other

State where samples were collected: CT  
 \* SURCHARGE APPLIES \*

Project P.O.:  
 Report to: Jay Webb  
 Invoice to: Same

This section MUST be completed with Bottle Quantities.

Cooler: Yes  No   
 Coolant: IPK  ICE   
 Temp 9 °C Pg of

Contact Options:  
 Fax:   
 Phone:   
 Email:

Temp 9 °C Pg of



# Section 50 70 00 Statement of Special Inspections



655 Winding Brook Drive  
Glastonbury, CT 06033  
t: 860.657.2500 f: 860.657.0757

July 2, 2018

Peter B. McClure, P.E.  
Project Manager  
DAS/Division of Construction Services  
450 Columbus Blvd  
12<sup>th</sup> Floor North Tower  
Hartford, CT 06103

RE: BI-Q672C Enfield Armory Renovation

Peter,

To the best of my knowledge, information and belief, the project as described above does not require any Special Inspections during construction.

If you have any questions, please contact me.

Thank you,

A handwritten signature in blue ink that reads 'Stevanie Demko'. The signature is written in a cursive style.

Stevanie Demko

