ADDENDUM NO.: 4 DATE OF ADDENDUM: August 31, 2016

New Police Facility for
Western Connecticut State University
Danbury, CT
BI – RD– 273

Original Bid Due Date / Time:	September 7, 2016	1:00pm
Previous Addendums:	Addendum #3 dated 8/25/2016, Addendum #2 dated 8/23/2016, Addendum #1 dated 8/2/2016	

TO: **Prospective Bid Proposers:**
This Addendum forms part of the "Contract Documents" and modifies or clarifies the original "Contract Documents" for this Project dated 7/01/2016. Prospective Bid Proposers shall acknowledge receipt of the total number the Addenda issued for this Project on the space provided on Section 00 41 00 Bid Proposal Form. Failure to do may subject Bid Proposers to disqualification.

The following clarifications are applicable to drawings and specifications for the project referenced above.

Item 1

Contractor RFI: Drawing SC6.02 Details Security is included in the drawing TOC, but we did not receive this drawing. Please clarify.

Answer: Delete all reference to drawing,"SC6.02 Details Security"

Item 2

Contractor RFI: Specs 312314 Structural Excavation, 312324 Structural Fill & 315004 Earthwork Protection – these specs are included in the spec manual, but not listed in TOC. Please clarify.

Answer: These specification sections were listed in the TOC, but not included in the manual. **Add** specification sections Specs 312314 Structural Excavation, 312324 Structural Fill & 315004 Earthwork Protection.

Item 3

Contractor RFI: Section 01 20 00, page 8 of 16: Please confirm that the Substitution Request Form can be submitted post bid.

Answer: Per specification section 01 25 00 paragraph D1, substitution requests will only be considered for contract items no longer available.

Item 4

Contractor RFI: Is this project to be LEED certified?

Answer: No.

Item 5

Contractor RFI: Regarding Flag Poles: The specifications states fiberglass flagpoles and the drawings state aluminum ground set flagpoles. If aluminum is required please provide spec.

Answer: Provide and install fiberglass flagpoles as specified.

ADDENDUM NO.: 4 **DATE OF ADDENDUM: August 31, 2016**

Item 6

Contractor RFI: There seems to be a conflict concerning the aluminum metal panels. The elevations call out insulated metal panels and the specs list IMP and ACM. The spec also states 6mm thickness and later on in the spec it calls for 4mm. Please clarify the panel material and thickness.

Answer: Metal Panels are to be 4mm minimum insulated panels.

Item 7

Contractor RFI: Building Insulation – the parapet calls to be filled with the specified closed cell insulation. This will necessitate multiple lifts as the foam can only be installed in 2" max lifts, resulting in the roof being delayed.
a. Will alternate insulation (vapor barrier with fiberglass or blown cellulose) be permitted ILO the spec to fill the parapet?
b. Will less insulation be acceptable, not filling the cavity? If so, please provide R-value.
c. Will spray insulation installed below the parapet be acceptable? If so, please provide R-value.

Answer: A.) No B.) No. C.) No.

Item 8

Contractor RFI: Drawing A9.01: Please confirm door type HM-3 is NIC

Answer: **Revise** door 124 to be type HM-3.

Item 9

Contractor RFI: Spec 11 31 00, 1.6A: GE has stated to us that due to the owner being non-residential, a 9 year and 5 year warranties are not available. Please confirm one year as being acceptable.

Answer: Contractor is to purchase an extended warrantee to provide coverage to the limits specified.

Item 10

Contractor RFI: The specified security system, CCure 800, is no longer being made as of 4/30/16. Please advise.

Answer: Furnish and install all hardware for security system as called for on the drawings.

Item 11

Add the following to specification section 01 52 13 paragraph C1:

Contractor shall provide cleaning services, including trash removal, provision of new trash liners in trash receptacles, maintenance of stock of extra trash liners, and floor cleaning (vacuuming/mopping) for the Construction Administrator and Owner's Trailer at minimum of once per week. Coordinate cleaning activities with occupants.

1.2 ADD: For each desk, provide one (1) stapler, one (1) Scotch Tape dispenser, one (1) three-hole punch, one (1) box #2 pencils, one (1) box each blue, black and red pens, one (1) box each blue, black and red permanent markers, one (1) box each yellow, blue, green and pink highlighters.

1.9 ADD: For each drawer, provide one (1) box of hanging files, one (1) box Three-tab file folders with adhesive labels

1.11 ADD: including stock of extra liners.

1.12 ADD: Provide toner cartridges/ inkjets to keep machine operational for duration of project. Provide copier paper in letter, legal and 11x17 sizes to keep machine operational for duration of project.

ADDENDUM NO.: 4 **DATE OF ADDENDUM: August 31, 2016**

1.18 ADD: Provide miscellaneous office supplies: ten (10) note pads, letter size lined paper, ten (10) each white D-ring binders in sizes 2", 3", 4", five (5) boxes each small, medium and large binder clips and five boxes each large and small paper clips.

Item 12

DELETE: Specification section 01 90 00 Commissioning

ADD: Specification section 01 91 13 General Commissioning Requirements.

Item 13

Contractor RFI: Please issue interior elevations for the men's and women's locker rooms showing the extent of the wall tile.

Answer: Wall tile is to be installed on wet walls from floor to ceiling in toilet and shower areas of the Locker Rooms. Walls that are not wet walls are to have epoxy paint as scheduled.

All questions must be in writing (not phone or e-mail) and must be forwarded to the consulting Architect/Engineer (Mark Allen, Jacunski Humes Architects, LLC, 860.828.9223) with copies sent to the DCS Project Manager (Peter Simmons, 860.713.7261) and Construction Manager (Michael Dell'Accio, Arcadis U.S., Inc, 860.503.1520)

End of Addendum 4

Mellanee Walton

Mellanee Walton, Associate Fiscal Administrative Officer
Department of Administrative Services
On Behalf of the Division of Construction Services

SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

A. Commissioning Scope

B. Systems to be Commissioned

C. Responsibilities

D. Commissioning Team

E. Pre-Functional and Functional Check Lists

1.3 RELATED SECTIONS

A. Division 1 – General Conditions and Requirements

B. Division 21 – Fire Suppression

C. Division 22 - Plumbing

D. Division 23 – Heating, Ventilating and Air Conditioning

E. Division 26 – Electrical

F. Division 27 - Communications

G. Division 28 – Electronic Safety and Security

1.4 SCOPE

A. The work under this Section is subject to requirements of the Contract Documents including the Owner's General Conditions, Supplementary Conditions, and Division 1 – General Requirements.

1.5 DESCRIPTION OF WORK

A. The objective of commissioning is to provide documented confirmation that a facility fulfills the functional and performance requirements of the building owner, occupants, and operators. To reach this goal, it is necessary for the commissioning process to establish and review the owner's criteria for system function, performance, and maintainability (Design Intent); and to also verify and document compliance with these criteria at start-up, and the initial period of operation. In addition, complete operation and maintenance (O&M) manuals, as well as training on system operation, should be provided to the building operators to ensure the building continues to operate as intended.

B. The Commissioning Agent (CA) shall be involved throughout the warranty phase. During construction, the CA develops and coordinates the execution of a testing plan, which includes

observing and documenting all systems' performance to ensure that the systems are functioning in accordance with the owner's Design Intent (DI) requirements and the contract documents. The CA is not responsible for design or general construction scheduling, cost estimating, or construction management, but may assist with problem-solving or resolving non-conformance issues or deficiencies. The installing Contractors, TAB Sub and ATC Sub shall be required to provide support of the commissioning under their base Contracts.

C. The following is a summary of services provided for commissioning:
1. Develop commissioning plan
2. Develop pre-functional and functional test procedures
3. On-site reviews to confirm that systems are ready for commissioning
4. Witness piping and ductwork tests
5. Witness system flushing
6. Review system start-up reports
7. Maintain master deficiency and resolution log
8. Perform prefunctional and functional testing
9. Ensure O&M and commissioning documentation requirements are complete.
10. Coordinate Owner staff training
11. Final report and presentation to Owner
12. Follow up visits after occupancy to review building operations

D. Commissioning does not reduce responsibility of installing contractors to provide a finished and fully functioning product.

E. This section shall in no way diminish the responsibility of the Divisions 21, 22, 23, 26, 27, 28 Contractors, Sub-contractors and Suppliers in performing all aspects of work and testing as outlined in the Contract Documents. Any requirements outlined in this section are in addition to requirements outlined in those divisions.

1.6 ABBREVIATIONS

A. The following are common abbreviations used in the Specifications. Definitions are found further in this Section.
1. A/E - Architect and Design Engineers
2. BAS - Building Automation System
3. CA - Commissioning Agent
4. CM - Construction Manager
5. CT - Commissioning Team
6. Cx - Commissioning
7. Cx Plan - Commissioning Plan
8. CC - Controls Contractor
9. EC - Electrical Contractor
10. FPT - Functional Performance Test
11. MC - Mechanical Contractor
12. OR - Owner's Representative
13. PC - Pre-functional Checklist
14. TAB - Test, Adjust and Balance
15. O&M - Operations & Maintenance
16. RFI - Request for Information

B. The following Standards shall be used where referenced by the following abbreviations:
1. AABC Associated Air Balance Council
2. ACGIH American Conference of Governmental Industrial Hygienists
3. ADC Air Diffusion Council
4. AGA American Gas Association
5. AIA American Institute of Architects
6. AMCA Air Moving and Conditioning Association
7. ANSI American National Standards Institute
8. API American Petroleum Institute

9. ARI Air Conditioning and Refrigeration Institute
10. ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
11. ASME American Society of Mechanical Engineers
12. ASPE American Society of Plumbing Engineers
13. ASSE American Society of Sanitary Engineers
14. ASTM American Society of Testing and Materials
15. NIST National Institute of Standards and Technology
16. SBI Steel Boiler Industry (Division of Hydronics Institute)
17. SMACNA Sheet Metal and Air Conditioning Contractors National Association
18. UL Underwriters' Laboratories

1.7 DEFINITIONS

A. Acceptance Phase: Phase of construction after start-up and initial checkout when Functional Performance Tests, O&M documentation review and training occur.

B. Approval: Acceptance that a piece of equipment or system has been properly installed and is functioning in tested modes according to the Contract Documents.

C. Architect/Engineer (A/E): Prime consultant (architect) and subconsultants who comprise the design team, generally HVAC Mechanical Designer/Engineer and Electrical Designer/Engineer.

D. Basis of Design: Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions and methods chosen to meet intent.

E. Commissioning Agent (CA): Contracted to Owner. CA directs and coordinates day-to-day commissioning activities. CA reports directly to Owner.

F. Commissioning Plan: Overall plan developed after bidding that provides structure, schedule and coordination planning for commissioning process.

G. Construction Manager (CM): The prime contractor for this project. Generally refers to the CM's subcontractors as well. Also referred to as the Contractor in some contexts. The CM is hired by the Owner and is authorized to overseen fulfillment of all requirements of the Contract Documents.

H. Contract Documents: Documents binding on parties involved in construction of this project (drawings, specifications, change orders, amendments, contracts, etc.).

I. Control System: System and components associated with building automation system.

J. Deferred Functional Tests: Functional tests performed after substantial completion due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow test from being performed.

K. Deficiency: Condition of a component, piece of equipment or system that is not in compliance with Contract Documents (that is, does not perform properly or is not complying with design intent).

L. Functional Performance Test Procedures: Commissioning protocols and detailed test procedures and instructions that fully describe system configuration and steps required to determine if the system is performing and functioning properly. These procedures shall be used to document Functional Performance Tests.

M. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems. Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, life safety conditions, power failure, etc. Systems are run through all specified sequences of operation. Components are

verified to be responding in accordance with Contract Documents. Functional Performance Tests are executed after pre-functional checklists and start-ups are complete.

N. Monitoring: Recording of parameters (flow, current, status, pressure, etc.) of equipment operation using data loggers or trending capabilities of control systems.

O. Overridden Value: Writing over a sensor value in control system to see response of a system (e.g., changing outside air temperature value from 72° F to 52° F to verify economizer operation). See also "Simulated Signal".

P. Pre-Functional Checklist (PC): A list of static inspections and elementary component tests that verify proper installation of equipment (e.g., belt tension, oil levels, labels affixed, gauges in place, sensors calibrated, etc.).

Q. Seasonal Performance Tests: Functional Performance Tests deferred until system(s) ambient conditions are closer to design conditions.

R. Simulated Condition: Condition created for testing component or system (e.g., applying heat to space temperature sensor to monitor response of VAV box).

S. Simulated Signal: Disconnecting sensor and using signal generator to send amperage, resistance or pressure transducer and/or DDC system to simulate value to BAS.

T. Specifications: Construction specifications of Contract Documents.

U. Start-up: The activities where systems or equipment are initially tested and operated. Start-up is completed prior to functional testing.

V. Sub-contractor: Contractors of CM, and their sub-contractors, who provide and install building components and systems.

W. Test Procedures: Step-by-step process, which must be executed to fulfill test requirements.

X. Test Requirements: Requirements specifying what modes and functions will be tested. Test requirements are not detailed test procedures and are identified in the Cx Plan.

Y. Trending: Monitoring using building control system.

Z. Vendor: Supplier of equipment.

AA. Warranty Period: Warranty period for entire project, including equipment components.

1.8 COORDINATION

A. Commissioning Team: Members of Commissioning Team (CT) will consist of:
1. Commissioning Agent (CA)
2. Owner's Representative(s) (OR)
3. Construction Manager (CM)
4. Architect and Design Engineers (A/E)
5. Mechanical Contractor (MC)
6. Electrical Contractor (EC)
7. Test and Balance Agency (TAB Agency)
8. Controls Contractor (CC)
9. Equipment Suppliers and Vendors

B. Management: Owner will contract services of the CA. The CA directs and coordinates commissioning activities and reports to OR. All members of the Commissioning Team shall cooperate to fulfill responsibilities and objectives of the Contract Documents.

C. Kick-off Meeting: Within 90 days of commencement of construction, CA will plan, schedule and conduct a commissioning kick-off meeting. Membership and responsibilities of the commissioning team will be clarified at this meeting. CA will distribute meeting minutes to all parties.

D. Scheduling:
1. A/E will work with commissioning team to establish required commissioning activities to incorporate in preliminary commissioning schedule. The CM will integrate commissioning activities into master construction schedule. Representatives of the commissioning team will address scheduling problems. Necessary notifications are to be made in a timely manner in order to expedite commissioning.
2. The CA will provide initial schedule of primary commissioning events at commissioning kick-off meeting. As construction progresses, more detailed schedules are developed by the commissioning team.

1.9 SUBMITTALS

A. Contractor shall provide CA with documentation required for commissioning work. At minimum, documentation shall include: Full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details, start-up reports. In addition, installation and checkout materials actually shipped inside equipment and actual field checkout sheet forms used by factory or field technicians shall be submitted to CA.

B. CA shall review submittals for conformance as it relates to commissioning. Review is primarily intended to aid in development of functional testing procedures and only secondarily to verify compliance with equipment specifications. The CA shall not be part of the A/E's submittal approval process.

1.10 START-UP PLAN

A. Sub-contractor responsible for purchase, installation and start-up of equipment develops and submits start-up plan by combining manufacturer's detailed start-up and checkout procedures with normally used field checkout sheets. Plan shall include checklists and procedures with specific boxes or lines for recording and documenting inspections of each piece of equipment.

B. A/E reviews submitted start-up plan for content and format. Primary role of A/E is to substantiate written documentation for each manufacturer-recommended procedure.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

A. Division contractors shall provide all specialized tools, test equipment and instruments required to execute start-up, checkout and functional performance testing of equipment under their contract.

B. Test equipment shall be of sufficient quality and accuracy to test and/or measure system performance with tolerances specified. A testing laboratory shall have calibrated test equipment within the previous 12 months. Calibration shall be NIST traceable. Equipment shall be calibrated according to manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 COMMISSIONING OVERVIEW

A. The following provides a brief overview of typical commissioning tasks during construction and general order in which they occur:

1. Commissioning prior to construction (where applicable) begins with the review of the pre-determined SD, DD and CD sets of plans. The CA will review the respective plans, comment on them and return the comments to the appropriate parties and wait for a response. No comments were provided in this instance as the CA was brought on board after this portion of work. A pre-installation meeting was held prior to the project going out to bid.
2. Commissioning during construction begins with a kick-off meeting conducted by CA where membership of commissioning team is established and responsibilities reviewed.
3. A Commissioning Plan is written up based on the project requirements.
4. CA schedules subsequent meetings as necessary to plan, coordinate and schedule commissioning activities. Deficiencies and problem resolution will also be discussed at these meetings.
5. Sub-contractors develop and submit detailed start-up plans to Cx team.
6. CM develops, with cooperation of Sub-contractor/vendor, detailed training plan. Training plan is reviewed and approved by commissioning team.
7. CA develops specific pre-functional checklists and equipment and system Functional Performance Test procedures. Commissioning team members review procedures.
8. Sub-contractors inform CA when the pre-functional items are complete by phase. The CA executes and documents pre-functional checklists in phases such as setting equipment, piping equipment, insulating it, making up electrical connections, etc. The purpose is to execute the process as the work is being completed.
9. The Sub-contractors perform start-up and initial checkout. CA collects documentation completed according to approved plans. CA will witness start-up of selected equipment.
10. Functional Performance Tests are executed by Sub-contractors, under supervision of and documented by CA.
11. Items of non-compliance in material, installation or set-up will be corrected at Sub-contractors expense and system shall be retested.
12. CM coordinates training sessions and executes training plan. Specific training to be provided as specified in Divisions 1, 21, 22, 23, 26, 27 and 28 by Sub-contractor/vendor. CA will witness and document selected training sessions.

3.2 SYSTEMS TO BE COMMISSIONED

Please note that while some equipment/systems will be commissioned in full (100%) most will be commissioned by a percentage of equipment. A representative sample will be chosen for inspection/testing for most equipment. The commissioning process shall include but shall not be limited to the following disciplines and components. Component types shall be according to the latest contract documents.

1. HVAC Systems
   a. Automatic Temperature Controls
   b. Hot Water system including Boilers, Pumps, piping, and components
   c. Air Handling Units/Rooftop Units
   d. VAV Boxes, associated reheat coils and dampers
   e. Dry cooler system and associated indoor computer air handling units
   f. All Exhaust Fans including Kitchen Hood
   g. All Cabinet Unit Heaters and Unit Heaters
2. Plumbing Systems/Plumbing Fixtures
3. Electrical Power Systems
   a. Emergency Generator and Automatic Transfer Switch
   b. Main Switchboards and Distribution Panels
   c. Wiring System
   d. Grounding System
   e. Normal Lighting Systems
   f. Emergency Lighting System
   g. Fire Alarm System and Campus Connections
   h. Security System including card readers and door release
   i. Data System wiring
   j. CCTV
4. Sprinkler Systems
   a. Dry pipe sprinkler system serving the attic and sallyport
   b. Wet pipe sprinkler system throughout the building

3.3 RESPONSIBILITIES

A. Responsibilities of commissioning team members are:

1. Architect/Engineer (A/E):
   a. Document design intent of systems
   b. Witnesses first run of primary equipment as necessary
   c. Review test documentation
   d. Review functional performance trend log data
   e. Review training plan
   f. Review O&Ms and record documents
   g. Attend commissioning kick-off meeting

2. Commissioning Agent (CA):
   a. Identify commissioning activities for inclusion into the project schedule by the CM.
   b. Develop detailed project specific pre-functional performance tests and Functional Performance Test procedures.
   c. Provide progress reports of commissioning status.
   d. Execute pre-functional checklists.
   e. Witness FPTs. Document test results and recommend system for acceptance.
   f. Review, track and coordinate resolution of non-compliance and deficiencies identified by commissioning team. Maintain records of all issues submitted by commissioning team.
   g. Review completed TAB reports.
   h. Review training plan developed by CM.
   i. Monitor completion and accuracy of project closeout documents and training.
   j. Provide final commissioning report, summarizing final disposition of building systems after functional testing.
   k. Develop or oversee and review development of systems manual for provision to owner and for any requirements necessary associated with CT High Performance Building.
   l. Facilitate cooperation of CT in commissioning work.
   m. Attend and conduct commissioning team meetings.
   n. Witness seasonal or deferred testing and modify or update commissioning report as required.
   o. Participate in a warranty review of system/equipment performance.

3. Construction Manager (CM):
   a. Incorporate commissioning activities into the construction schedule.
   b. Periodically update commissioning activities in the construction schedule.
   c. Develop, with cooperation of A/E and Sub-contractor/vendor, detailed training plan.
   d. CM coordinates training sessions and executes training plan through his sub-contractors.
   e. Facilitate cooperation of Sub-contractors in commissioning work.
   f. Submit copies of approved submittals, with manufacturer start-up criteria, contractor start-up checklists and operating and maintenance criteria to CA.
   g. Verify equipment and systems are ready for execution of pre-functional checklists by the CA. Assures CA at each phase of installation equipment and systems are ready.
   h. Insures resolution of non-compliance and deficiencies of construction related items identified by commissioning team. Obtains written documentation of completion from the appropriate Sub-contractors.
   i. Coordinate Sub-contractor/vendor participation in training sessions. Provide workspace or conference room as needed. Ensure attendance at training is documented.
   j. Schedule, coordinate and assist CT in seasonal or deferred testing.
   k. Participate in warranty review of system/equipment performance.

4. Sub-contractors/Vendors:
   a. Review commissioning plan, pre-functional checklists, and FPT procedures.

b. Ensure installation work and pre-functional test sheets are completed and that work is complete and is in compliance with Contract Documents and is ready for Functional Performance Testing.
c. Develop and submit detailed equipment start-up procedures to CT. Procedures shall include checklist to be completed by Sub-contractor/vendor.
d. Perform testing in accordance with specification requirements and/or per the requirements of the local authority
e. Notify CT that equipment and systems are ready for functional performance testing.
f. Execute FPTs developed by CA as described in Contract Documents and commissioning plan, under direction of CA.
g. Provide certified and calibrated instrumentation required to take measurements of system and equipment performance during functional performance testing.
h. Assist CT with developing a comprehensive commissioning schedule.
i. Attend commissioning kick-off meeting and other commissioning team meetings.
j. Prepare training plans with CM and execute training as specified in Division 1, 21, 22, 23, 26, 27 and 28 of these specifications.
k. Execute seasonal or deferred functional performance testing as necessary.
l. Make necessary amendments to O&M manuals and as-built drawings for applicable issue identified in season/deferred testing.
m. Provide CA with (Systems Manual) individually tabbed binder which includes maintenance procedures, trouble shooting charts, maintenance logs and exploded parts lists per each type of equipment. Intent of this maintenance binder is to provide building Owner with quick reference guide for maintenance procedures.
n. Participate in a warranty review of system/equipment performance.

5. Controls Contractor (CC):
a. Completely install and thoroughly inspect components, thoroughly start-up, test, adjust, calibrate and document systems and equipment under Building Automation/Controls Contract.
b. Provide laptop computer, software and training to accommodate TAB Contractor in system balancing.
c. Install software on CA's laptop and provide training to CA for off-site trend logging and monitoring "BMS".
d. Maintain database of control parameters submitted by TAB Contractor subsequent to field adjustments and measurements.
e. Provide on-site technician skilled in software programming and hardware operation to exercise sequences of operation and to correct control deficiencies identified during functional performance testing.
f. Provide instrumentation, computer, software and communication resources necessary to demonstrate total operation of building systems during functional performance testing of control system equipment.
g. Attend commissioning kick-off meeting and other commissioning team meetings.
h. Prepare training plans with CM and execute training as specified in Division 1, 21, 22, 23, 26, 27 and 28 of these specifications.
i. Maintain comprehensive system calibration and checkout records. Submit records to CT.
j. Set up trend logs as requested by CT to substantiate proper systems operation.
k. Participate in a warranty review of system/equipment performance.
l. Provide computer generated reports and signed documentation indicating the commands listed below function as intended:
1) All installed points receive and transmit the correct information prior to loading/activating the system software.
2) ON/OFF commands from the workstation shall be performed in order to verify each binary output.
3) Each binary input point is to be tested using the HOA (hand/off/automatic) selector switch on the associated motor control panel or by manually completing the circuit across the field device contacts.

4) Each analog output points providing control shall be tested using a command from the workstation confirming the signals are properly sent and received
5) Each analog input point is to be tested by comparing the reading obtained through the workstations to the value of an independent testing meter.
6) All equipment programmed with a Sequence of Operations is to be verified; all heating/cooling modes, valves hot and chilled water, dampers, fans, energy recovery wheels, sensors, mechanical cooling, and all other associated equipment components are to be tested and checked out prior to CA functional testing.

6. Test, Adjust and Balance (TAB) Agency:
   a. Attend commissioning kick-off meeting and other commissioning team meetings.
   b. Submit TAB plan and forms describing methodology for execution of test and balance procedures specific to this project to CT for review.
   c. Cooperate with CC with execution of required work.
   d. Rebalance deficient areas identified during commissioning.
   e. Provide on-site technician, as necessary, skilled in TAB procedures to provide verification of equipment and system performance and TAB reading during functional performance testing.
   f. Participate in a warranty review of system/equipment performance.

3.4 COMMISSIONING TEAM (CT) MEETINGS

A. CT meetings will be held periodically as determined by CA with frequency increasing as construction advances and systems become operational. Attendance is mandatory. CA will record minutes and attendance. CA will chair CT meetings.

B. Discussions held in CT meetings shall include, but not be limited to system/equipment start-up, progress, scheduling, testing, documentation, deficiencies and problem resolution.

3.5 REPORTING

A. CA will provide regular status reports to CM and Owner, with increasing frequency as construction and commissioning progresses.

B. CA will regularly communicate with members of commissioning team, keeping them apprised of commissioning progress.

C. CA shall submit non-compliance and deficiency reports to Owner and CM.

D. CA shall provide a final summary report to Owner.

3.6 START-UP AND INITIAL CHECKOUT

A. Sub-contractor shall schedule equipment start-up with Commissioning Team. Sub-contractor shall execute equipment start-up.

B. CA reserves the right to witness any start-up or equipment testing.

C. Pre-functional checklists are provided and executed by CA. Prototypical examples of PFCs are included at the end of this specification section. Final copies of PFCs will be developed after issuance the Construction Documents and issued to the CT as part of the Commissioning Plan. CM and Sub-contractor shall review final construction documentation for applicable details and specifications related to equipment to be commissioned in order to fully ascertain all of the pre-functional checklist requirements.

3.7 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope:
1. The objective of Functional Performance Testing is to demonstrate each system is operating according to documented design intent and Contract Documents. Functional Performance Testing facilitates bringing system from a state of substantial completion to full dynamic operation. Additionally, during Functional Performance Testing, areas of deficient performance are identified and corrected, improving operation and functioning of systems.
2. Each system shall be operated through all modes of operation (occupied, unoccupied, warm-up, cool-down, etc.) where there is a specified system response. Verifying each sequence in the sequences of operation is required.

B. Development of Test Procedures:
1. The purpose of any given specific test is to verify and document compliance with stated criteria of acceptance given on test form. CA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Sub-contractor responsible to execute test will provide assistance to CA in developing procedure (i.e., answering questions about equipment, operation, sequences, etc.) Prior to execution, CA shall provide a copy of test procedures to Sub-contractor. Sub-contractor will review tests for feasibility, safety and equipment warranty protection. CA shall submit tests to Owner, CM and A/E and other Commissioning Team members for review.
2. Test procedure forms developed by the CA will include (but not be limited to) the following information:
   a. System and equipment or component name(s)
   b. Date
   c. Project name
   d. Specific sequence of operation or other specified parameters being verified
   e. Specific step-by-step procedures to execute test, in a clear, sequential and repeatable format
   f. A Yes/No checkbox to allow for clearly marking whether or not proper performance of each part of the test was achieved
   g. Section for comments
3. Prototypical examples of Functional Performance Test Checklists are included at the end of this specification section. Final copies of FPTs will be developed after issuance the Construction Documents and issued to the CT as part of the Commissioning Plan. CM and Sub-contractors shall review final construction documentation for applicable details and specifications related to equipment to be commissioned in order to fully ascertain all FPT requirements.

C. Coordination and Scheduling:
1. CM will provide sufficient notice to CA regarding completion of schedule for equipment and systems. CM will schedule Functional Performance Test with CT. CA shall witness and document functional testing of equipment and systems. Sub-contractor shall execute test under direction of CA.
2. Functional Performance Testing is conducted after system operation and checkout is satisfactorily completed. Air balancing and water balancing is completed and debugged before functional testing of air-related or water-related equipment or systems.

3.8 DOCUMENTATION, NON-COMFORMANCE AND APPROVAL OF TESTS

A. Documentation:
1. CA will witness and document results of FPT using specific Functional Performance Test developed for that purpose. Prior to testing, FPTs are provided to the Commissioning Team for review and approval. CA will include filled out FPTs in Commissioning Turnover Package.

B. Non-Conformance:
1. CA will record results of functional testing. Deficiency or non-conformance issues will be noted and reported to CM and Owner on standard non-compliance FPT form.
2. Corrections of minor deficiencies identified may be made during tests at discretion of CA. In such cases, deficiency and resolution will be documented on FPT form.
3. Every effort will be made to expedite testing and minimize unnecessary delays, while not comprising integrity of tests. CA shall not overlook deficient work or relax acceptance criteria to satisfy scheduling or cost issues unless directed to do by the Owner.
4. Deficiencies are handled in the following manner:
   a. When there is no dispute on deficiency and Sub-contractor accepts responsibility for remedial action:
      1) CA documents deficiency and Sub-contractors response and intentions and they go on to another test or sequence. CA submits deficiency report to CM and Owner. Copy is provided to Sub-contractor. Sub-contractor corrects deficiency, and verifies correction to CM. CM forwards response to CA.
      2) CM reschedules test with Sub-contractor.
   b. When there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
      1) CA documents deficiency and Contractors response and they go on to another test or sequence. CA submits deficiency report to CM and Owner. Copy is provided to Sub-contractor.
      2) CM facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive authority is A/E. Final acceptance authority is with the Owner.
      3) CM documents resolution process.
      4) Once interpretation and resolution has been decided, appropriate party corrects deficiency, and verifies correction to CM. CM forwards response to CA. CM reschedules test and test is repeated until satisfactory performance is achieved.

C. Cost of Retesting:
1. Sub-contractor shall retest FPT, if they are responsible for deficiency at no additional cost.
2. Time for CA to direct any retesting required because a specific pre-functional checklist or start-up test items reported to have been successfully completed, but determined during Functional Performance Testing to be faulty, may be backcharged to Sub-contractor.

D. Approval:
1. CA notes each satisfactorily demonstrated function on test form. CA, A/E and Owner provide formal approval of FPT. CA recommends acceptance of each test to Owner.

3.9 COMMISSIONING DOCUMENTATION

A. Commissioning Turnover Package
1. CA is responsible to compile and organize commissioning records. CA shall deliver Cx records to the Owner in Commissioning Binders. Turnover Package to include the following:
   a. Commissioning Plan
   b. Pre-functional Checklists
   c. Completed Functional Performance Test records
   d. Deficiency Reports
   e. Final Commissioning Report

B. Final Report Details
1. Final Commissioning Report will include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope and general description of testing and verification methods. Recommendations for improvement to equipment or operations, future actions, etc., will also be listed. Each non-compliance issue will be referenced to specific FPT where deficiency is documented.

3.10 TRAINING OF OWNER PERSONNEL

A. Sub-contractors will provide complete training in start-up, operation and maintenance of all equipment under contract.

B. CM and Sub-contractors will be responsible for developing Owner training plan, scheduling of Owner training, execution of Owner training and documentation of completed Owner training.

C. A/E will be responsible for approving content and adequacy of Owner training.

D. CA will be responsible for reviewing training plans and monitoring completion of Owner training.

E. Sub-contractor will submit a written training plan to A/E and CA for review and approval with submission of shop drawings. Plan will cover the following elements:
1. Equipment (included in training)
2. Intended audience
3. Location of training
4. Objectives
5. Subjects covered
6. Duration of training on each subject
7. Instructor for each subject
8. Methods (lecture, video, site walk, actual operational demos, written handouts, etc.)
9. Instructors and qualifications

F. CM and sub-contractors schedule training with CA and Owner. CA develops criteria to determine training satisfactorily completed.

G. CM shall provide videotaping of training sessions.

3.11 SYSTEMS MANUAL

A. The Contractor(s) shall provide a systems manual that gives future operating staff the information needed to understand and optimally operate the project's commissioned systems. Input shall be provided by the Design Team, CA, Owners Team and Contractor(s) and shall be reviewed and approved by the Owner and CA. This manual is intended to improve and enhance the documentation of system intent and operation to help the building owner continue to operate the building systems as efficiently and effectively as possible throughout the life of the facility. The manual should cover the operations and maintenance of all HVAC and lighting systems, and the facility staff should cover the operations and maintenance of all HVAC and lighting systems, and the facility staff should be trained in the use of the manual.

3.12 DEFERRED TESTING

A. Deferred Seasonal Testing:
1. During warranty period, seasonal testing (test delayed until weather conditions are closer to system's design) will be completed as part of this contract. CM will coordinate this activity. Tests will be executed, documented and deficiencies corrected by the appropriate sub-contractor(s), with CA witnessing. CA will incorporate final updates to Turnover Package as necessary.

B. Unforeseen Deferred Tests:
1. Any check or test not completed due to building structure, required occupancy condition, or other deficiency, may be delayed upon approval of Owner. These tests will be rescheduled as soon as possible.

NOTE: The prototypical Pre-Functional Checklists and Functional Performance Test procedures are enclosed.
END OF SECTION 01 91 13

Functional Test

AIR HANDLING UNITS

IMPORTANT:

Please refer to the Master Deficiency and Resolution Log for numbers referenced in parentheses, which will indicate deficiencies discovered and resolved. For quick reference you will find, in the front of this section a list of Master Deficiency and Resolution Log items pertaining only to this section.

1. Submittal / Approvals

Submittal. The above equipment and systems integral to them are complete and ready for functional testing. A Statement of Correction will be submitted upon completion of any outstanding areas.

2. Prerequisite Checklist

a. All associated equipment has been started up, is operational and is ready for functional testing.
b. All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final setpoints and schedules with debugging, loop tuning and sensor calibrations completed.
c. Test and balance (TAB) completed and approved for the hydronic systems and terminal units connected.
d. All A/E punchlist items for this equipment corrected.
e. Safeties and operating ranges reviewed.
f. Schedules and setpoints attached.
g. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures.
h. Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
i. Contractor's assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.

3. Installation Checks

Check if Okay. Enter comment or note number if deficient.

Check Equip Tag→	AHU's	Comments
Cabinet and General Installation		
Permanent labels affixed, including for fans		
Casing condition good: no dents, leaks, door gaskets installed		
Access doors close tightly - no leaks		
Boot between duct and unit tight and in good condition		
Vibration isolation equipment installed & released from shipping locks		
Maintenance access acceptable for unit and components		
Thermal insulation properly installed and according to specification		
Instrumentation installed according to specification (thermometers, pressure gages, flow meters, etc.)		
Clean up of equipment completed per contract documents		
Filters installed and replacement type and efficiency permanently affixed to housing--construction filters removed		
Unit Configuration is correct		
Valves, Piping and Coils		
Pipe fittings complete and pipes properly supported		
Pipes properly labeled		
Pipes properly insulated		
Strainers in place and clean		
Piping system properly flushed		
No leaking apparent around fittings		
All coils are clean and fins are in good condition		
Condensate drains with P-trap or capped where appropriate		
Valves properly labeled		
Valves installed in proper direction		
OSAT, MAT, SAT, RAT, hot water, chilled water supply sensors properly located and secure (related OSAT sensor shielded)		
Sensors calibrated		
Isolation valves installed per drawings		
Fans and Dampers		
Supply fan and motor alignment correct		
Supply fan belt tension & condition good		
Supply fan area clean		
Supply fan and motor properly lubricated		
Return fan and motor aligned		
Return fan belt tension & condition good		
Return fan area clean		
Return fan and motor lube lines installed and lubed		
Filters clean and tight fitting		
Filter pressure differential measuring device installed and functional (magnahelic, inclined manometer, etc.)		

Check if Okay. Enter comment or note number if deficient.

Check Equip Tag➔	AHU's	Comments
All dampers close tightly		
All damper linkages have minimum play		
Low limit freeze stat sensor located to deal with stratification & bypass		
Ducts		
Ducts properly insulated		
Duct joint sealant properly installed		
No apparent severe duct restrictions		
Turning vanes in square elbows as per drawings		
OSA intakes located away from pollutant sources & exhaust outlets		
Balancing dampers installed as per drawings and TAB's site visit		
Electrical and Controls		
Power disconnects in place and labeled		
All electric connections tight		
Safeties in place and operable		
Control system interlocks hooked up and functional		
Smoke detectors in place		
All control devices wiring complete		
Service light if provided is operational		

The checklist items of Part 3 are all successfully completed for given trade ☐ ***YES*** ☐ ***NO***

4. Operational Checks

Check if Okay. Enter comment or note number if deficient.

Check Equip Tag→	AHU's	Comments
General Findings		
Operation of Dampers and Valves		
Dampers stroke fully without binding and spans calibrated and BAS reading site verified.		
Valves stroke fully and easily and spanning is calibrated.		
Valves verified to not be leaking through coils when closed at normal operating pressure.		
Operator Station Display to read as follows:		
System graphic		
System On/Off indication		
System Occupied/Unoccupied mode		
System supply fan On/Off indication		
Return exhaust fan status On/Off indication		
Outside air temp indication		
Outside air humidity indication		
Outside air enthalpy calculation		
Supply air temperature		
Supply air temperature setpoint		
Return air temperature		
Damper positioning (%)		
Supply static pressure setpoint		
Supply static pressure		
Hot water coil valve position		
Chilled water coil valve position		
Space/average space temperature		
CO2 indication and setpoint		
All alarm indications		

The checklist items of Part 4 are all successfully completed for given trade ☐ ***YES*** ☐ ***NO***

4. Functional Testing Record

AHU- #

Test#	Mode ID	Test Procedure	Expected Response	Pass Y/N	Note
1	Unoccupied Mode	Using BMS put unit into unoccupied mode. Using the trend log features ensure the following occurs	OA temp is above 40°F. - Verify Outside Air and Exhaust Dampers are Closed and return air damper is open, HW/CHW coil valves are closed		
			OA temp is below 40°F – The HW heating coil valve is 25% open subject to safeties.		
		Unit in unoccupied with a call for heat – If Average temperature drops 2 degrees below the unoccupied heating setpoint of 60°F (adj)	OA damper shall remain closed. Subject to safeties, supply fan shall cycle and 3-way valve shall open based on call for heat from space sensor. Once space temp is 1°F above unoccupied setpoint, the supply fan shuts down. Ensure areas with perimeter radiation use radiant heat as 1st stage if applicable		
2	Morning Warm-up	Set up trends for morning warm up status, heating control valve temperature, discharge air temperature and supply fan status	Check trending to verify that the warm up cycle is occurring prior to the occupied mode enable. OA dampers remain closed, SF starts, and HW valve opens 100%. The supply fan VFD shall modulate to maintain static pressure setpoint.		
3	Occupied, Fan On	Return unit to occupied mode using BMS.	Outside, return and relief damper opens to minimum position, supply fan and return fan start (once OA damper is proven open), RA damper modulates inverse of OA damper.		
4	Supply Fan and Return Fan Control	Using BMS set unit to occupied mode	Supply fan starts and runs continuously during occupied times. Return fan VFD shall track the supply fan by an adjustable offset as determined by the balancer.		
		Manually fail the supply fan and return fan	Verify an alarm is generated at the BMS		
5	Economizer Control	Simulate a situation, using the BMS controls where the unit is looking for cooling and the OA enthalpy is less than 22 btu/lb.	HW valve closed, OA damper modulates to 100% open.		
6	Chilled Water Cooling Coil	With a need for cooling, set the enthalpy setpoint below the actual OA enthalpy	The Chilled water cooling coil shall open and cool air shall be delivered		
		Create a situation where there is a need for cooling, the economizer damper is at 100% open and the cooling setpoint is not satisfied	The economizer damper shall remain 100% open and the chilled water cooling coil valve shall open. Cool air shall be delivered.		
7	Hot Water Heating Coil	In occupied mode, with fan running, raise the space temperature setpoint	Verify the hot water coil valve modulates to satisfy the heating requirement. (Ensure the system resets Supply air temperature to maintain space temp (adj.))		
8	Smoke Control	Simulate a smoke condition	Verify the duct smoke detectors will send a signal to stop the fans and close the OA dampers		
9	Freeze Condition	Manually simulate a freeze condition at the low limit duct thermostat	Verify the supply fan stops, OA dampers close, heating coil valve opens (when tempfalls below 40°F) and an alarm is sent to the BMS		
		Manually reset the alarm	The alarm shall be cleared and the units shall be capable of restarting		

10	Filter Switch	Simulate a dirty filter condition	Ensure that the BMS reports an alarm		
11	(CO_2 Override)	Simulate a CO2 level beyond the adjustable setpoint	The outside air damper shall be allowed to modulate past minimum position until the CO2 concentration has fallen below setpoint		

The checklist items of Part 5 have all passed for given trade ☐ ***YES*** ☐ ***NO***

31 23 14 STRUCTURAL EXCAVATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including the General and Supplementary Conditions, apply to the work specified in this Section.

1.2 SCOPE OF WORK

A. The work under this Section includes all labor, supervision, materials and equipment necessary for the completion of all building structure excavation within the building and excavation five (5') feet outside the building for structures and utility lines, as shown on the Drawings and as specified.

B. Work shall include, but not be limited to, the following:

1. Building excavation, including pits and trenches for utilities within the building
2. Protection of utilities
3. Stockpiling of reusable materials
4. Removal of unsuitable materials
5. Rock excavation

1.3 RELATED WORK

A. Section 31 23 24 - Structural Fill
B. Section 31 50 04 - Earthwork Protection

1.4 TEST BORINGS

A. Subsurface investigations have been made at the site. This data was obtained for use in designing foundations, and is made available to all bidders solely for their information. Interpretation of subsurface data for purposes of construction is the responsibility of the Contractor.

B. There is no guarantee of the accuracy of this information, and the Owner or the Architect or the Structural Engineer shall not be responsible for any differences between the data given and the actual subsurface conditions or subsurface materials.

PART 2 - PRODUCTS - Not applicable

PART 3 - EXECUTION

3.1 EXCAVATION

A. Excavate all areas as required to perform work shown on Drawings and to conform to new finish grades. Excavations shall be to proper depth and width to allow for slabs, gravel bases and other subsequent construction.

B. Excavate to depth and lineal dimensions required to permit subsequent formwork and concrete operations to proceed without hindrance. Excavation for footings, walls, piers, grade beams, etc., must be sufficiently wide to compact all fill by mechanical means. In general, excavation shall be cut to a line eighteen (18") inches outside of the face of footings, with no undercutting permitted.

C. Surfaces of excavations shall be suitably dressed to grade noted to receive subsequent construction. Bottoms shall be substantially level, with no large projections, and free of loose material. Material at bottoms of excavation shall be undisturbed. The Engineer shall be immediately notified if material unsatisfactory for foundation bearing is encountered, for further instructions, before proceeding with work.

D. Trenches and excavations shall be of sufficient width and depth at all points to allow all pipes to be laid, joints to be formed, and structures and appurtenant construction to be built in most thorough and workmanlike

manner, and to allow for sheeting and shoring, pumping and draining. Trenches and excavations shall be at least eighteen (18") inches wider than outside dimension of structures they are to contain. Trenches for pipes must not be unnecessarily wide so as to materially increase load on pipe resulting from backfill. Bottoms of trenches and other excavations shall be carried to lines and shapes satisfactory to Engineer.

E. Completely remove all abandoned subsurface utilities, structures and existing foundations within the lines of the new building construction. Plug abandoned utility lines at least five (5') feet outside of new construction.

F. If footing bottoms are disturbed, allowed to freeze, or if excavations for footings are carried below indicated elevations shown on the Drawings, the Contractor shall notify the Engineer for instructions prior to proceeding.

3.2 PROTECTION OF UTILITIES

A. Protect existing utilities and relocate only as shown on Plans or in Specifications.

B. Notify utility companies to shut off services when required.

C. Any damage to existing drainage and utility structures to be retained shall be repaired at the Contractor's expense.

D. Maintain drainage of site and adjacent areas to prevent damage and erosion. When necessary to interrupt drainage of existing facilities, provide temporary facilities until permanent installations have been completed.

3.3 REMOVAL OF UNSUITABLE MATERIALS

A. Remove all debris subject to termite attack, rot or corrosion and all other deleterious materials from areas to be filled.

B. Remove from the interior of the building all unsuitable materials such as topsoil, loam or other organic materials.

C. Remove from site, all excavated materials not required for fill.

3.4 STOCKPILES

A. Approved excavated material suitable for fill or structural fill (i.e., clean granular material) shall be stockpiled.

3.5 ROCK EXCAVATION

A. Definition: Rock is defined as ledge, stone or hard shale, concrete, or masonry structures which require drilling or blasting for removal, and boulders larger than one (1 cy) cubic yard in volume within the building excavation and one-half (1/2 cy) cubic yard in volume encountered in trench excavations.

B. Measurement: Rock shall be stripped for measurement before proceeding, and no rock excavated or loosened before measurement will be allowed or paid for as rock. Measurement and payment therefore shall be by the number of cubic yards required to bring the excavation to the required surface or grade shown on the Drawings. In making rock excavation, eighteen (18") inches will be allowed outside the footing lines, in vertical planes; twenty-four (24") inches will be allowed outside walls without footings and outside footings where drains are required. Submit cross-sections and certification of quantities by a Connecticut Registered Land Surveyor or Professional Engineer.

C. Blasting: When explosives are used, work shall be executed by experienced powdermen or persons who are licensed or otherwise authorized to use explosives. Explosives shall be stored, handled and used in accordance with local regulations and the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Incorporated. Structural Engineer shall be notified of scheduled blasting. Any damage to existing or new construction caused by the use of explosives shall be corrected at the Contractor's expense.

D. Shelving: If rock surfaces supporting footings should be encountered, such surfaces shall be leveled off to a slope not exceeding one inch per foot (1"/ft) unless otherwise indicated on the plans.

E. Payment: It is anticipated that no rock, as above defined, will be encountered in the construction. However, if it should be encountered, payment will be made in accordance with the Unit Prices agreed upon before rock excavation commences.

END OF SECTION 312314

31 23 24 STRUCTURAL FILL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including the General and Supplementary Conditions, apply to the work specified in this Section.

1.2 SCOPE OF WORK

A. The work under this Section includes all labor, supervision, materials and equipment necessary for the completion of all structural fill.

B. Work shall include, but not be limited to the following:

1. Structural Fill
2. Compaction
3. Testing

1.3 RELATED WORK

A. Section 31 23 14 - Structural Excavation
B. Section 31 23 24 - Earthwork Protection

1.4 SUBMITTALS

A. The Contractor shall submit for approval to the Engineer prior to commencing operations a sieve analysis, a modified proctor density test of proposed structural fill material, and drainage filter material. The tests shall be prepared by an approved testing laboratory at the Contractor's expense.

B. A sample of each approved material shall be kept at the Construction Site Field Office for comparison purposes during this phase of work.

C. Any material which does not reasonably conform to the approved sieve analysis shall be subject to removal.

1.5 FIELD INSPECTION AND TESTING

A. The Owner shall retain and pay for an independent soils laboratory to perform inspection and/or testing of structural backfill. The laboratory will have an inspector on the site during backfilling operations and will make tests required for fill and backfill placed.

B. The following field tests shall be performed:

1. One modified Proctor Density Test for each source of fill material performed in accordance with ASTM D1557.

2. Standard field density tests, each of an accuracy of plus or minus one (1%) percent.

C. Field density tests shall be at the rate of one (1) per two hundred (200 cy) cubic yards of fill, or at the discretion of the inspector. The tests shall be made at a maximum height differential of sixteen (16") inches throughout the fill.

D. It shall be the Contractor's responsibility to notify the Engineer and Testing Laboratory when each layer of fill is to be in place and ready for testing. The Contractor shall allow ample time for testing. If any fill is placed in excess of sixteen (16") inches without testing, it shall be subject to removal.

E. All required compaction and retesting due to unsatisfactory compaction shall be at the Contractor's expense.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Structural fill shall be clean gravel, free from foreign substances, lumps of clay, silt, loam or vegetable matter. The gravel shall be sound, tough, durable and free from thin elongated pieces. The material shall meet the following gradation requirements:

1.	Sieve Size	3 1/2"	1/4"	No. 10	No. 40	No. 100
2.	Percent Passing	100	30-65	20-55	5-30	0-5

2.2 LOCATION OF MATERIALS

A. Structural fill shall be used for all backfill under all slabs on grade, under all footings required to achieve footing base elevations for all backfill against exterior basement and retaining walls, to extend a distance of five (5') feet beyond the face, including that backfill required for structural or utility excavation and trenches within the limits of the outermost foundation walls of the building.

PART 3 - EXECUTION

3.1 CONSTRUCTION METHODS

A. Structural fill shall be deposited in eight (8") inch layers and compacted to the following percent optimum density (ASTM D1557):

1. Ninety-five (95%) percent under footings and under all slabs on grade, trenches, sidewalks, driveways and paved areas, against interior face of foundation walls and retaining walls.
2. Ninety (90%) percent against exterior face of foundation walls and retaining walls.

B. No material shall be compacted when its moisture content is greater than optimum.

C. The excavation must be sufficiently dry to permit complete inspection of the excavation and to permit use of compaction machinery on the initial layers of fill. The excavation must be kept sufficiently dry to carry out placement of fill and compaction thereof as specified below.

D. It shall be the responsibility of the General Contractor to notify the laboratory when excavation is complete so that inspection of conditions before filling may be made.

E. Compacting equipment shall not be of a nature so as to cause unstable conditions in the underlying natural soil.

F. No backfilling will be permitted against foundation walls until floor slabs at both top and bottom of walls have been placed and cured, or unless walls have been adequately braced. Where backfill occurs on both sides of a wall, levels of backfill on each side shall be kept approximately equal at all times.

G. Do not place structural fill or backfill on frozen material. Do not place frozen fill material.

H. If grade freezes or excavation bottom freezes, remove frozen material to extent of freezing prior to placing new structural fill or backfill material.

END OF SECTION 312324

31 50 04 EARTHWORK PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Provisions of the Contract, including the General and Supplementary Conditions, apply to the work specified in this Section.

1.2 SCOPE OF WORK

A. The work under this Section includes all labor, supervision, materials and equipment necessary for the completion of earthwork protection as specified.

B. Work shall include, but not be limited to, the following:

1. Protection of work and property
2. Stability of sides
3. Shoring and bracing
4. Drainage and pumping

1.3 RELATED WORK

A. Section 31 23 14 - Structural Excavation
B. Section 31 23 24 - Structural Fill

PART 2 - PRODUCTS - Not applicable

PART 3 - EXECUTION

3.1 PROTECTION OF WORK AND PROPERTY

A. Protect structures, utilities, sidewalks, pavements and other facilities immediately adjacent to structure excavation from damage caused by settlement, lateral movement, undermining, washout and other hazards.

B. Take precautions and provide necessary bracing and shoring to guard against movement or settlement of existing improvements or new construction. The Contractor is solely responsible for the strength and adequacy of bracing and shoring; and for the safety and support of construction from damage or injury caused by the lack thereof, of movement and/or settlement.

C. Protect excavation, trenches and all items of subsurface construction from damage by rain, water from melted snow, surface water and subsurface water. Provide all pumps, equipment, and enclosures necessary to ensure such protection.

D. Protect exposed earth and foundations in excavation areas when the atmospheric temperature is less than 35 degrees F by covering with dry insulating materials of sufficient depth to prevent frost penetration of soil.

3.2 STABILITY OF SLOPES

A. Slope the sides of excavations over five (5') feet to the angle of repose of the material excavated; otherwise, shore and brace where sloping is not possible either because of space restrictions or stability of material excavated. Maintain sides and slopes of excavations in a safe condition until completion of backfilling by benching, shelving or bracing.

B. Take precautions to prevent slides or cave-ins when excavations are made in locations adjacent to backfilled excavations, and when sides of excavations are subjected to vibrations from vehicular traffic or the operation of machinery or any other source.

3.3 SHORING, SHEETING AND BRACING

A. Contractor shall furnish, install in place, and maintain such sheeting, shoring, and bracing as may be required to support sides of excavations and to prevent any movement which could in anyway injure work, diminish necessary width of trench or other excavations, or otherwise delay work or endanger adjacent structures. Sheeting shall be driven and excavation work conducted in such a manner as to prevent material in back of sheeting from running under sheeting and into trench.

B. Provide steel or timber materials for sheeting, shoring and bracing, such as sheet piling, uprights, stringers, rangers and cross-braces, in good serviceable condition. Use timbers that are sound and free of large or loose knots. Maintain shoring and bracing in excavations, regardless of the time period excavations will be open. Carry down shoring and bracing as the excavation progresses.

C. Provide trench shoring and bracing to comply with the provisions of ANSI A10.2 "Safety Code for Building Construction", and with requirements of the local codes and authorities having jurisdiction.

D. The Contractor shall, prior to driving sheeting, determine the presence and extent of underground structures as may affect the driving of sheeting.

E. Care shall be taken to prevent voids outside of sheeting; but if voids are formed, they shall be immediately filled and well rammed. Sheeting shall not be carried to such depth at manholes that it will bear upon pipe. Special precautions, by using sheeting, shoring and bracing shall be taken to guard against any damage to or settlement of buildings, walls or other structures which are adjacent to work.

F. Sheeting shall not unnecessarily be driven below structures and thereby necessitate its being left permanently in place.

G. Bracing, rangers and sheeting shall be securely fastened in place so that they cannot loosen up and fall from position. Sheeting, shoring, bracing, etc., or parts thereof, shall be removed after completion of work.

3.4 DRAINAGE AND PUMPING

A. Perform excavation in a manner to prevent surface water from flowing into the excavations, and to prevent water from flooding the project site and surrounding area. Do not allow water to accumulate in excavations. Remove water from excavations using dewatering methods which will prevent softening of foundation bottoms, undercutting of footings, and soil changes detrimental to the stability of subgrades and foundations.

B. Provide and maintain pumps, sumps, suction and discharge lines and other dewatering system components necessary to convey the water away from excavations. Convey water removed from excavations and rain water to runoff areas. Provide and maintain temporary drainage ditches and other diversions outside the excavation limits for each structure. Do not use trench excavations for site utilities as temporary drainage ditches.

END OF SECTION 315004