



**State of Rhode Island
Department of Administration / Division of Purchases
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November 19, 2012

ADDENDUM # 3

RFQ # 7458181

**TITLE: STUDENT DEVELOPMENT ATHLETIC CENTER AT
TOOTELL AND KEANEY**

OPENING DATE AND TIME: 11/27 2012 (EST) AT 10:00 AM

Notice to Vendors:

The following Addendum Number 3 forms a part of the Contract Documents and modifies the original specifications and drawings dated July 20, 2012

Thomas Bovis
Interdepartmental Project Manager

Interested parties should monitor this website, on a regular basis, for any additional information that may be posted.

**Student Athletic Development Center
University of Rhode Island
Kingston Campus**

ADDENDUM NUMBER 3

November 16, 2012

The following Addendum Number 3 forms a part of the Contract Documents and modifies the original specifications and drawings dated July 20, 2012, for the Student Athletic Development Center at the University of Rhode Island, Kingston Campus.

This Addendum Number 3 consists of 13 pages, plus 68 sheets of attachments, totaling 81 sheets.

SPECIFICATIONS

Item 1

SECTION 00010 – TABLE OF CONTENTS:

- a. **ADD** the following sections:
 - Section 019110 General Commissioning Requirements
 - Section 220800 Plumbing Commissioning Requirements
 - Section 230800 HVAC Commissioning Requirements
 - Section 230993 Sequence of Operations for HVAC Controls
 - Section 239010 BAS Commissioning Requirements
 - Section 260800 Electrical Commissioning Requirements
- b. **CHANGE** Section 092116 to read “Gypsum **Board** Assemblies”.

Item 2

SECTION 00015 – LIST OF DRAWINGS:

- a. **ADD** the following drawings:
 - A5.3 Signage (to Architectural)
 - M1.4 Mechanical Elevator Plan Alternate #4 (to Mechanical)
- b. **CHANGE** drawing M2.3 to read “Air Flow Diagram”.

Item 3

SECTION 01201 – PRICE AND PAYMENT PROCEDURES – Attachment A:

- a. At Article C, paragraph 1 **CHANGE** Strength/Conditioning room number to read “T125A”.
- b. At Article C, paragraph 3 **CHANGE** Lobby room number to read “T101A”.

Item 4

SECTION 01500 – TEMPORARY FACILITIES AND CONTROLS: At Article 1.06, paragraph B **CHANGE** to read “If existing ventilation fans are used during construction, clean fans **and replace filters** in areas of work after Substantial Completion.”

Item 5

SECTION 019110 – GENERAL COMMISSIONING REQUIREMENTS: **ADD** new Section 019110 “General Commissioning Requirements” consisting of 20 pages attached herewith to the Project Manual.

Item 6

SECTION 024119 – SELECTIVE DEMOLITION: At Article 1.07, **CHANGE** Paragraph E to read as follows:

“E. Asbestos Containing Materials: Asbestos Containing Materials may be encountered in the Work of this Contract. Abatement of Asbestos Containing Material is included in the Scope of Work of this contract.

1. Testing for asbestos has been conducted at the facility scheduled for renovation, demolition, reconstruction, alteration, remodeling, or repair. The results are in this Project Manual. Results of the asbestos testing are for information purposes only. Under no circumstances shall this information be the sole means used by the Contractor for determining the extent of asbestos. The Contractor shall be responsible for verification of all field conditions affecting performance of the Work.
2. Additional requirements applicable to Asbestos Containing Materials are included in Division 2 Section “Hazardous Materials – General Requirements” and “Asbestos Abatement”.

Item 7

SECTION 033000 – CAST-IN-PLACE CONCRETE: At Article 1.4, **CHANGE** Paragraph B to read as follows:

“B. Green Design Submittals:

1. Products Having Recycled Content: Documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.”

Item 8

SECTION 042000 – UNIT MASONRY ASSEMBLIES:

- a. At Article 1.02, Paragraph A **ADD** subparagraph 8 to read “Face brick”.
- b. At Article 1.03, Paragraph B **DELETE** subparagraph 2.
- c. At Article 1.03, Paragraph C **ADD** subparagraph 2 to read: “Face brick, in the form of straps of five or more bricks”.
- d. At Article 1.03, paragraph D, subparagraph 3 **ADD** sub-subparagraph c to read: “Face brick, in the form of straps of five or more bricks”.
- e. At Article 1.03, paragraph D **DELETE** subparagraph 3.
- f. At Article 1.03, paragraph G, subparagraph 1 **ADD** subparagraphs as follows:
 - b. “For bricks, include size-variation data verifying that actual range of sizes falls within specified tolerances.

- c. For exposed brick, include material test report for efflorescence according to ASTM C 67.”

- g. **ADD** Article 2.14 as follows:

2.14 “BRICK

- A. General: Provide shapes indicated and as follows for each form of brick required:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
3. Provide special shapes for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

- B. Face Brick: ASTM C 216, Grade SW, and as follows:

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 3000 psi.
2. Initial Rate of Absorption: Less than 20 g/30 sq. in. per minute when tested per ASTM C 67.
3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."

- d. 4. Where shown to match existing, provide face brick matching color range, texture, and size of existing adjacent brickwork.”

- h. At Article 3.02, **ADD** paragraph H to read:

“H. Wetting of Brick: Wet brick before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at the time of laying.”

Item 9

SECTION 051200 – STRUCTURAL STEEL: At Article 1.4 **CHANGE** paragraph C to read as follows:

- “C. Green Design Submittals:

1. Products Having Recycled Content: Documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.”

Item 10

SECTION 053100 – STEEL DECK: At Article 1.3 **CHANGE** paragraph C to read as follows:

“C. Green Design Submittals:

1. Products Having Recycled Content: Documentation indicating percentages by weight of postconsumer and preconsumer recycled content.
 - a. Include statement indicating costs for each product having recycled content.”

Item 11

SECTION 054000 – COLD-FORMED METAL FRAMING:

- a. At Article 1.04, paragraph A, and all subparagraphs **CHANGE** the phrase “Base Bid” to read “Bid”. (This work is included with the alternates as well.)
- b. At Article 1.04, paragraph B, subparagraphs 3 and 4 **CHANGE** the phrase “Base Bid” to read “Bid”.
- c. At Article 1.04, paragraph C **CHANGE** the phrase “Base Bid” to read “Bid”.
- d. At Article 1.05, paragraph B **CHANGE** the phrase “Base Bid” to read “Bid”.
- e. At Article 1.06, paragraph B **CHANGE** the phrase “Base Bid” to read “Bid”.
- f. At Article 1.06, paragraph H **CHANGE** the Division 1 reference to “Administrative Requirements”.

Item 12

SECTION 055000 – METAL FABRICATIONS: **DELETE** Articles 2.07 Steel Deck and 3.05 Installation of Metal Deck. (See Section 053100.)

Item 13

SECTION 064023 – INTERIOR ARCHITECTURAL WOODWORK:

- a. At Article 1.05, paragraph H **CHANGE** the Division 1 reference to “Administrative Requirements”.
- b. At Article 2.01, paragraph G **ADD** a second sentence to read: “Material must contain at least 6% preconsumer recycled content.”
- c. At Article 2.08 **CHANGE** paragraph E to read: “Edge Treatment: Wood bullnose as shown on Drawings.”

Item 14

SECTION 070150.91 – MEMBRANE ROOFING:

- a. At Article 1.03, paragraph A **CHANGE** subparagraphs to read as follows:
 1. “Section 01100 Summary
 2. Section 01600 Execution Requirements
 3. 01732 Waste Management”
- b. At Article 1.09, **CHANGE** paragraph F to read: “Hazardous Materials: If materials suspected of containing hazardous materials are encountered, remove as part of this contract. Existing roof shall be left no less watertight than before removal.”

Item 15

SECTION 071716 – BENTONITE WATERPROOFING:

- a. At Article 1.02, paragraph B, **CHANGE** subparagraph 2 to read “Division 31 Section “Earthwork and Reseeding “ for excavation and earthwork.”
- b. At Article 1.05 paragraph D **CHANGE** the Division 1 reference to “Administrative Requirements”.

Item 16

SECTION 074213 – METAL WALL PANELS: At Article 1.02, paragraph B **DELETE** subparagraph 2.

Item 17

SECTION 078413 – THROUGH-PENETRATION FIRESTOP SYSTEMS: At Article 1.02, paragraph B, **CHANGE** subparagraph 5 to read “Division 26 and 27 Sections specifying cable and conduit penetrations”.

Item 18

SECTION 079200 – JOINT SEALANTS: At Article 1.04, paragraph D **CHANGE** the Division 1 reference to “Administrative Requirements”.

Item 19

SECTION 081113 – STEEL DOORS AND FRAMES: At Article 1.05, paragraph E **CHANGE** the Division 1 reference to “Administrative Requirements”.

Item 20

SECTION 081416 – FLUSH WOOD DOORS: At Article 2.06, **DELETE** paragraphs B and D.

Item 21

SECTION 083116 – ACCESS PANELS AND FRAMES:

- a. At Article 1.02, paragraph B **CHANGE** subparagraph 2 to read “Division 20 Section “General Conditions for Mechanical and Electrical Systems”.
- b. At Article 2.02, **CHANGE** paragraph F to read “Stainless Steel Sheet, Strip Plate, and Flat Bars: ASTM A 666 Type **304**: with minimum sheet thickness...”

Item 22

SECTION 084400 – GLAZED ALUMINUM CURTAIN WALLS:

- a. At Article 1.02, paragraph A **ADD** subparagraph 3 to read “Sunshade Assemblies: Installed with curtain wall systems.”
- b. At Article 1.05, paragraph K **CHANGE** the Division 1 reference to “Administrative Requirements”.

Item 23

SECTION 087100 – DOOR HARDWARE:

- a. At Article 1.2, paragraph C **CHANGE** subparagraphs as follows:
 1. “Division 08 Section Steel Doors and Frames.
 2. Division 08 Section Flush Wood Doors.
 3. Division 08 Section Aluminum Framed Entrances and Storefronts.
 4. Division 26 Section Electrical.
 5. Division 27 Section Communications.
 6. Division 28 Section Fire Alarm Systems.”
- b. At Article 1.3, paragraph A **DELETE** subparagraph 20. (General contractor, not Construction Manager as Adviser)
- c. At Article 1.3, paragraph B **CHANGE** subparagraph 2 to read “Rhode Island State Fire Safety/Protection Code, 2008 Edition, as amended.”
- d. At Article 1.3, paragraph B **ADD** subparagraph 7 to read “International Green Construction Code (IGCC), 2012 edition.”
- e. At Article 1.4, **CHANGE** paragraph A to read “The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental goals, which include conforming to the Rhode Island Green Buildings Act 2010. Specific project goals include: use of recycled materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirement related to these goals are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor of subcontractors, shall not be allowed if such changes compromise the Green Building criteria.”

Item 24

SECTION 092116 – GYPSUM BOARD ASSEMBLIES:

- a. At Article 1.05, paragraph A **CHANGE** the Division 1 reference to “Administrative Requirements”.
- b. At Article 2.02, paragraph B **CHANGE** the second sentence to read “...shall be made as part of the Bid, and **any** costs for increases in materials and labor therefore shall not be passed on to the Owner.”

Item 25

SECTION 092400 – PORTLAND CEMENT PLASTER:

- a. At Article 1.04, paragraph D **CHANGE** the Division 1 reference to “Administrative Requirements”.
- b. At Article 2.02, paragraph B **CHANGE** the Division 9 reference to “Gypsum Board Assemblies”.

Item 26

SECTION 093013 – CERAMIC TILE:

- a. At Article 1.02, paragraph B **CHANGE** subparagraph 1 to read “Division 2 Section “Selective Demolition” for removing existing finishes.”

- b. At Article 2.02, paragraph A **CHANGE** subparagraph 6 to read “Basis-of-Design Product: American Olean; Unglazed ColorBody Porcelain Mosaics, price group 1, or a comparable product...”
- c. At Article 2.02, paragraph B **CHANGE** subparagraph 6 to read “Basis-of-Design Product: Daltile; Div. of Dal-Tile International Inc.; Lodge ColorBody Glazed Porcelain (light polished), or a comparable product...”
- d. At Article 2.05, **CHANGE** paragraph C to read “Polymer-Modified Tile Grout: ANSI A118.7, color as selected by Architect.”

Item 27

SECTION 095113 – ACOUSTICAL PANEL CEILINGS: At Article 1.05, paragraph E **CHANGE** the Division 1 reference to “Administrative Requirements”.

Item 28

SECTION 095129 – SUSPENDED WOOD PANEL CEILINGS:

- a. At Article 1.04, paragraph G **CHANGE** the Division 1 reference to “Administrative Requirements”.
- b. At Article 2.04, paragraph B, **CHANGE** subparagraph 5 to read “Cap Finish: Tech black.”

Item 29

SECTION 096253.13 – SYNTHETIC TURF FLOORING: At Article 1.05, paragraph E **CHANGE** the Division 1 reference to “Administrative Requirements”.

Item 30

SECTION 096566.53 – RESILIENT SHEET ATHLETIC FLOORING:

- a. At Article 1.02 **DELETE** paragraph C.
- b. At Article 1.03 **DELETE** paragraph E.
- c. At Article 1.05, paragraph A **CHANGE** the Division 1 reference to “Administrative Requirements”.
- d. At Article 2.01, **CHANGE** paragraph A to read “Resilient Sheet Athletic Flooring RBR-2 Basis-of-Design Product: Mondo America, Inc., Sport Impact.”
- e. At Article 2.02, **CHANGE** paragraph A to read “Resilient Sheet Athletic Flooring RBR-3, 3A, and 3B Basis-of-Design Product: Infinity Performance, Inc., Infinity Max.”

Item 31

SECTION 096816 – CARPET: At Article 1.02, paragraph B **CHANGE** subparagraph 1 to read “Division 2 Section “Selective Demolition” for removing existing floor coverings.”

Item 32

SECTION 101100 – VISUAL DISPLAY SURFACES: At Article 1.05, paragraph E **CHANGE** the Division 1 reference to “Administrative Requirements”.

Item 33

SECTION 101401 – INTERIOR SIGN SYSTEM:

- a. At Article 1.02, paragraph B, subparagraph 2 **CHANGE** the second sentence to read “Although, not necessary to implement signage for **this Project**, sign contractors bidding for this work are encouraged...”
- b. At Article 1.05, paragraph B, subparagraph 2 **CHANGE** edition year to “2003”.

Item 34

SECTION 102226 – OPERABLE PANEL PARTITIONS:

- a. At Article 1.02, paragraph B **CHANGE** the Division 9 reference to “Gypsum Board Assemblies”.
- b. At Article 1.06, paragraph F **CHANGE** the Division 1 reference to “Administrative Requirements”.
- c. At Article 1.10, paragraph A **CHANGE** subparagraph 1 to read “Panel Finish-Facing Material: Furnish full width in quantity to cover both sides of **one panel** when installed.”

Item 35

SECTION 109000 – SPECIALTIES:

- a. At Article 2.01, paragraph A, subparagraph 4 **CHANGE** the last few words to read “...with requirements of Division 26 **and 27** sections.”
- b. At Article 3.03, paragraph 1 **CHANGE** the last sentence to read “Refer to Division 1 Section “Closeout Requirements”.

Item 36

SECTION 122413 – WINDOW SHADES:

- a. At Article 1.02, paragraph A **ADD** the following:
 3. “Metal shade pockets or housings recessed into ceiling system or assembly.
 4. Extruded aluminum ceiling pocket trim (closure) assemblies.”
- b. At Article 1.02 **DELETE** paragraph B.
- c. At Article 2.03, paragraph A **CHANGE** to read “...5% openness maximum, color...”
- d. At Article 3.01, paragraph A **CHANGE** to read “...within scope of work, **unless noted otherwise**, and interior...”
- e. At Article 3.02, paragraph A **CHANGE** subparagraph 1 to read “...Translucent Fabric: interior **lights and exterior windows of** Academic Suite, Sports Medicine, and offices”.
- a. At Article 3.02, paragraph A **CHANGE** subparagraph 2 to read “...at Strength & Conditioning curtainwall.”

Item 37

SECTION 124813 – FLOOR MATS AND FRAMES:

- a. At Article 1.02 **ADD** subparagraph B to read “Roll-up mat in existing recessed frame”.
- b. **ADD** Article 2.03 as follows:

“2.03 ROLL-UP MATS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Balco, Inc.
 - 2. Pawling Corporation.
 - 3. Arden Architectural Specialties, Inc.
 - 4. Reese Enterprises, Inc.
- B. Roll-up Aluminum-Rail Hinged Mats: Basis-of-Design is Pawling EM-65o Rol-Dek. Extruded aluminum tread rails 1-1/2 inches wide by 3/8 inch thick, sitting on continuous vinyl cushions.
 - 1. Tread Inserts: ¼ inch high, 28 oz./sq.yd. weight, level-cut, nylon-pile, fusion-bonded carpet.
 - 2. Colors, Textures, and Patterns of Inserts: As selected by Architect from manufacturer's full range.
 - 3. Rail color: Mill-finish.
 - 4. Hinges: Aluminum.
 - 5. Mat Size: As required to fit into existing frame.
- C. Structural Performance: Provide roll-up mats capable of withstanding the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform floor load of 300 lbf/sq.ft.
 - 2. Wheel load of 350 lb per wheel."

Item 38

SECTION 142100 – ELECTRIC TRACTION ELEVATORS:

- a. At Article 1.02, paragraph B, subparagraph 7 **CHANGE** the Division 27 reference to "Telecommunications Cabling."
- b. At Article 1.02, paragraph B, subparagraph 8 **CHANGE** the Division 28 reference to "Fire Alarm Systems."
- c. At Article 2.08, paragraph D **CHANGE** the Division 28 reference to "Fire Alarm Systems."
- d. At Article 2.09, paragraph A, subparagraph 8 **CHANGE** sub-subparagraph k to read "Handrails: 1-1/2 inches round, at sides and rear of car."
- e. At Article 3.05, paragraph A **CHANGE** the Division 01 reference to "Closeout Requirements."

Item 39

SECTION 144200 – WHEELCHAIR LIFTS:

- a. At Article 1.03, paragraph E **CHANGE** the Division 1 reference to "Closeout Requirements."
- b. At Article 1.04, paragraph C **CHANGE** the Division 1 reference to "Administrative Requirements."

Item 40

SECTION 220800 – PLUMBING COMMISSIONING REQUIREMENTS: **ADD** new Section 220800 "Plumbing Commissioning Requirements" consisting of 6 pages attached herewith to the Project Manual.

Item 41

SECTION 230800 – HVAC COMMISSIONING REQUIREMENTS: **ADD** new Section 230800 “HVAC Commissioning Requirements” consisting of 10 pages attached herewith to the Project Manual.

Item 42

SECTION 230993 – SEQUENCE OF OPERATIONS FOR HVAC CONTROLS: **ADD** new Section 230993 “Sequence of Operations for HVAC Controls” consisting of 9 pages attached herewith to the Project Manual.

Item 43

SECTION 232113 – HYDRONIC PIPING: At Article 2.22 **ADD** the sentence “Steam traps manufactured by Steam Guard shall be the Basis of Design” to the end of paragraph A.

Item 44

SECTION 239010 – BAS COMMISSIONING REQUIREMENTS: **ADD** new Section 239010 “BAS Commissioning Requirements” consisting of 7 pages attached herewith to the Project Manual.

Item 45

SECTION 260800 – ELECTRICAL COMMISSIONING REQUIREMENTS: **ADD** new Section 260800 “Electrical Commissioning Requirements” consisting of 6 pages attached herewith to the Project Manual.

DRAWINGS

Item 46

DRAWING A1.1 – PARTIAL FLOOR PLAN –FIRST FLOOR NORTH: **ADD** demising wall to storage room west of Natatorium as shown by attached sketch AD3-SK-A-1 titled “DEMISING WALL” dated 11/16/2012.

Item 47

DRAWING FF1 – FINISHED FLOOR PLAN - NORTH: **REVISE** platform flooring at each weight station as shown by attached sketch AD3-SK-FF titled “WOOD PLATFORMS” dated 11/16/2012.

Item 48

DRAWING S1.3 – NEW ELEVATOR AND OBSERVATION PLATFORM:

- a. **REVISE** Detail 1 “Pool Level Foundation Plan” as shown by attached sketch AD1-SK-S-1 titled “REVISED PARTIAL POOL FOUNDATION PLAN” dated 11/15/2012.
- b. **REVISE** Detail 2 “Bleacher Level Framing Plan” as shown by attached sketch AD1-SK-S-2 titled “REVISED PARTIAL BLEACHER LEVEL PLAN” dated 11/15/2012.

- c. **REVISE** Detail 3 “Ceiling Framing Plan” as shown by attached sketch AD1-SK-S-3 titled “REVISED PARTIAL CEILING FRAMING PLAN” dated 11/15/2012.
- d. **REVISE** Section 4 as shown by attached sketch AD1-SK-S-4 titled “REVISED SECTION 4/S1.3” dated 11/15/2012.
- e. **CHANGE** Section mislabeled as “3” to “4” as shown by attached sketch AD1-SK-S-5 titled “REVISED SECTION MARK” dated 11/15/2012.
- f. **ADD** Section 8 as shown by attached sketch AD1-SK-S-6 titled “NEW SECTION AT ELEVATOR PIT” dated 11/15/2012.

Item 49

DRAWING S2.2 – NEW ELEVATOR AND OBSERVATION PLATFORM: **REVISE** right-hand portion of Detail 3 “Section New elevator Shaft” as shown by attached sketch AD1-SK-S-7 titled “REVISED PARTIAL SECTION 3/S-2.2” dated 11/15/2012.

Item 50

DRAWING FP1.1 – FIRE PROTECTION FLOOR PLAN - NORTH: At Mechanical Room T125G **ADD** note “Provide sprinklers under existing duct and air handling unit. Connect to existing piping.”

Item 51

DRAWING PL1.1 – PLUMBING FLOOR PLAN – NORTH/SOUTH: At Hydrotherapy Room T103C **ADD** note “Floor sinks shall have 4” outlets and associated pipe shall be 4” diameter.”

Item 52

DRAWING PL2.1 – PLUMBING NOTES, DETAILS, RISER DIAGRAMS:

- a. At Hot and Cold Riser Diagram #3, **REVISE** to provide thermostatic mixing valves under lavatories.
- b. At Floor Drain Floor Sink Trench Drain Schedule, **REVISE** so that outlet and waste pipe on all floor sinks shall be 4”.

Item 53

DRAWING MD1.2 – MECHANICAL DEMOLITION FLOOR PLAN - SOUTH: At Training Space **DELETE** thermostat.

Item 54

DRAWING M1.2 – MECHANICAL FLOOR PLAN - SOUTH:

- a. At RTU-1 **REVISE** so that freeze pump P-2 serving heating coil shall be piped in parallel with pump P-1 as shown by attached sketch AD3-SK-M1 titled “MECHANICAL DETAILS” dated 11/15/2012.
- b. At Taping T113, **REVISE** so that 26”x10” transfer duct shall be lined.
- c. At Office T109, **REVISE** so that 12”x8” transfer duct shall be lined.
- d. At RTU-1 **REVISE** so that supply duct drop and first 10’-0” of horizontal duct (both directions) shall be wrapped with B-10LAG acoustical insulation manufactured by Sound Seal.

Item 55

DRAWING M2.1 – MECHANICAL SCHEDULES:

- a. At Roof Top Unit Schedule, **REVISE** Note 2 to read “Unit manufacturer shall provide 24” high, pitched vibration isolating roof curb.”
- b. At Roof Top Unit Schedule, **ADD** “Note 6. Unit manufacturer shall provide weatherproof Variable Frequency Drives for the supply and return air fans.”
- c. At Roof Top Unit Schedule, **ADD** “Note 7. This Contractor shall provide two layers of moisture resistant sheetrock and two layers of 2” thick acoustical foam with B20NR noise barrier by Sound Seal.”
- d. At Exhaust Fan Schedule, **REVISE** Note 2 to read “Unit manufacturer shall provide 18” seismic roof curb with backdraft damper.”
- e. At Exhaust Fan Schedule, **ADD** Note 6 for EF1, EF2, and EF7 to read “Unit manufacturer shall provide fan with two speed motor.”

Item 56

DRAWING M2.2 – MECHANICAL DETAILS: **ADD** note “Refer to AD3-SK-M1 for Typical Supply Duct, Typical Exhaust or Return Duct, Typical Grill Open to Ceiling Space, Register Connection, Ceiling Diffuser Branch Duct, and Typical Transfer Duct Details.”

BIDDER REQUESTS FOR INFORMATION

Item 57

Q: Structural Steel specification requires AISC Certified Fabricator. Please confirm this is required as it will limit the number of local steel fabricators to one or two shops.

A: Provide AISC Certified Fabricator as required by the Specifications.

Item 58

Q: Please confirm that ASI Signage is the manufacturer of record. There is no sign schedule that references the sign types on drawings A5.3; will a schedule be issued?

A: Per the last paragraph of General Notes on sheet A5.3, “sign types are keyed into the Door Schedule...” The Schedule for Openings on sheet A5.1 has a column for signage types just to the left of Notes.

Item 59

Q: In Section 070150 it mentions two types of roofing: PVC and Modified Bitumen. I need to know exactly the kind of roofing (fully adhered, ballasted, mechanically fastened, etc.) color, gauge and manufacturer.

A: Per Article 3.01, paragraph A, Contractor is responsible for verifying “in field component materials and application methods of existing roofing system to remain”.

LIST OF ATTACHMENTS

- Specification Section 019110 General Commissioning Requirements

- Specification Section 220800 Plumbing Commissioning Requirements
- Specification Section 230800 HVAC Commissioning Requirements
- Specification Section 230993 Sequence of Operations for HVAC Controls
- Specification Section 239010 BAS Commissioning Requirements
- Specification Section 260800 Electrical Commissioning Requirements
- Sketch No. AD1-SK-S-1 through S-7
- Sketch No. AD3-SK-M1

END OF ADDENDUM NUMBER 3

SECTION 019110 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objectives and criteria. The Commissioning process begins at project inception (during the pre-design phase) and continues through turnover and operation of the facility. The commissioning process includes specific tasks to be conducted during each phase in order to verify that design, construction, and training meets the Owner's project requirements.
- B. The members of the commissioning team consist of the commissioning agent (CxA), the Owner's Project Manager (OPM), the General Contractor (GC), the architects and design engineers of record (A/E), the mechanical contractor (MC), the plumbing contractor (PC), the electrical contractor (EC), the testing and balancing (TAB) contractor, the controls contractor (CC), the facility operating staff, and any other installing subcontractors or suppliers of equipment. The commissioning agent is hired by the Owner directly. The CxA directs and coordinates the project commissioning activities and the reports to the Owner. All team members work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- C. The Commissioning Program will verify the following:
 - 1. All applicable equipment and systems are installed according to the contract documents, manufacturers' recommendations, and industry accepted standards.
 - 2. Equipment receives adequate operational checkout by installing contractors and equipment suppliers.
 - 3. Proper performance of equipment and systems; in all operating modes and seasons is verified and documented.
 - 4. O&M documentation delivered to the Owner is complete.
 - 5. The Owner's operating personnel are adequately trained.
 - 6. Warranty issues have been resolved to Owner satisfaction.
- D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.

1.2 COMMISSIONING PROGRAM OBJECTIVES

- A. The purpose of commissioning is to verify that:
 - 1. Equipment and systems are installed in accordance with the project design documents, using good workmanship and industry standards
 - 2. Equipment has been cleaned, flushed, adjusted, lubricated and tested by qualified personnel, prior to start-up.
 - 3. Equipment has been started up and verified by qualified personnel, prior to overall system start-up.
 - 4. The systems operate in the manner intended for all modes of operation.

5. All equipment and system discrepancies have been resolved to the Owner's satisfaction.
6. Operations and maintenance training has been completed to the Owner's satisfaction.
7. All operational and warranty issues have been resolved to the Owner's satisfaction.

1.3 REFERENCES

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 01 specification sections, apply to this section.
- B. Owner's Project Requirements and Basis of Design.
- C. ASHRAE Guideline 0-2005 - "*The Commissioning Process*"
- D. ASHRAE Guideline 1.1-2007 - "*HVAC&R Technical Requirements for the Commissioning Process*"

1.4 SUMMARY

- A. This section includes general requirements that apply to the implementation of the commissioning process without regard to specific systems, assemblies, and components.
- B. This commissioning program shall also incorporate the equipment and system requirements described in the drawings and other project specification sections.

1.5 DEFINITIONS

- A. Acceptance - A formal action, taken by a person with appropriate provider (which may or may not be contractually defined) to declare that some aspect of the project meets defined requirements, thus permitting subsequent activities to proceed.
- B. Approval - Acceptance that a piece of equipment or system has been properly installed and is functioning in the tested modes according to the contract documents.
- C. Basis of Design - A document that records the concepts, calculations, decisions, and product selections used to meet the Owner's project requirements and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.
- D. Checklists - Verification checklists that are developed and used during all phases of the commissioning process to verify that the Owner's project requirements are being achieved. This includes checklists for general verification, plus testing, training, and other specific requirements.
- E. Commissioning Authority (CxA) - The entity identified by the Owner who leads, plans, schedules, and coordinates the commissioning team to implement the commissioning process.
- F. Commissioning Plan - An overall plan developed by the commissioning agent that provides the structure, schedule and coordination planning for the commissioning process.
- G. Commissioning Process - A quality-focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems and assemblies are planned, designed, installed, tested, operated, and maintained to meet the Owner's project requirements.

- H. Commissioning Process Progress Report - A written document that details activities completed as part of the commissioning process and significant findings from those activities that is continuously updated during the course of a project. Usually it is incorporated into the commissioning plan as an ongoing appendix.
- I. Commissioning Team - The individuals who through coordinated actions are responsible for implementing the commissioning process.
- J. Construction Checklist - A form used by the contractor to verify that appropriate components are on-site, ready for installation, correctly installed, FULLY programmed, and FULLY functional. Also see **Checklists**.
- K. Construction Documents - This includes a wide range of documents, which pertain to this project, with the Owner's needs and with regulations and laws. Construction documents typically include the project manual (specifications), plans (drawings) and general terms and conditions of the contract.
- L. General Contractor (GC) - The entity under contract to the Owner, who leads, plans, schedules, and coordinates the construction team to implement the materials & equipment procurement, construction, start-up, turnover, and warranty process. The GC coordinates schedules, subcontractors and resources so that the commissioning process is integrated into the overall construction program.
- M. Contract Documents - This includes a wide range of documents, which will vary from project to project, with the Owner's needs and with regulations and laws. Contract documents frequently include price agreements, construction management process, sub-contractor agreements or requirements, requirements and procedures for submittals, changes, and other construction requirements, timeline for completion, and the construction documents.
- N. Coordination Drawings - Drawings showing the work of all trades to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances.
- O. Control system - A component of environmental, HVAC, security, and fire systems for reporting/monitoring and issuing of commands to/from field devices.
- P. Deferred Performance Tests (DPTs) - Performance tests that are performed, at the discretion of the CxA, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design, or other site conditions that disallow the test from being performed.
- Q. Deficiency - A condition in the installation or function of a component, piece of equipment, or system that is not in compliance with the contract documents or the commissioning requirements.
- R. Factory Testing - Testing of equipment on-site or at the factory, by factory personnel, with or without an Owner's representative present.
- S. Issues Log - A formal and ongoing record of problems or concerns – and their resolution – that have been raised by members of the commissioning team during the course of the commissioning process.
- T. Owner's Project Manager (OPM): The OPM is responsible for the overall management of project components and for initial approval of all related invoices. Responsibilities of the OPM for a Project component(s) include, but are not limited to, monitoring the per-

formance by the GC according to terms and conditions of the GC Contract; acting as the Owner representative in charge of work at the site; ensuring compliance with GC Contract requirements concerning the work; and advising of any factors that may cause delay in performance of the work.

- U. Owner's Project Requirements (OPR) - A written document that details the functional requirements of a project and the expectations of how it will be used and operated. This includes project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. (The term "Project Intent" is used by some Owners for their commissioning process.)
- V. Phased Commissioning - Commissioning that is completed in phases as required by the phasing plan as approved for the project and other scheduling issues.
- W. Seasonal Performance Tests - Performance tests that are deferred until the system(s) will experience conditions closer to their design conditions based on weather conditions.
- X. Simulated Condition - Condition that is created for the purpose of testing the response of a system, such as modifying the setpoint of a thermostat to see the response in a VAV box.
- Y. Startup - The initial starting or activating of dynamic equipment, including completing construction checklists.
- Z. Systems Manual - A system-focused composite document that includes the operation manual, maintenance manual, and additional information of use to the Owner during the occupancy and operations phase.
- AA. Test Procedure - A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems. The test procedures are specified in the Technical Specifications sections of the contract documents. Performance testing covers the dynamic functions and operations of equipment and systems using manual or monitoring methods. Performance testing is the dynamic testing of systems under full operation. Systems are tested under various modes, such as during low cooling loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to respond as the sequences state.
- BB. Training Plan - A written document that details the expectations, schedule, budget, and deliverables of commissioning process activities related to training of the project's operating and maintenance personnel, users, and occupants.
- CC. Verification - The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project Requirements.
- DD. Trending - The monitoring, by a building management system or other electronic data gathering equipment, and analyzing of the data gathered over a period of time.
- EE. Vendor - Supplier of equipment.

1.6 COORDINATION

- A. Project Commissioning Team - The members of the project commissioning team will consist of the commissioning authority and any support personnel, the Owner's facility

staff or designee, the general contractor, subcontractors and/or vendors as required, and the architect/ engineer.

- B. Management - The CxA coordinates the commissioning activities through the Owner. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- C. Scheduling - The CxA, through the Owner or GC, will provide sufficient notice to the contractor for scheduling commissioning activities with respect to the Owner's participation. The contractor shall integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

1.7 COMMISSIONING PLAN

- A. The CxA will develop the commissioning plan which shall be included in the project schedule when approved by the Owner. The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 - 1. Commissioning during construction begins with an initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the project commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA, through the Owner or GC, with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve problems.
 - 3. Equipment documentation is submitted to the CxA, through the Owner or GC, during normal submittals, including detailed startup procedures.
 - 4. The construction checklists are to be developed by the CxA, and completed by the contractor or subcontractors, before and during the startup process. The CxA and the contractors shall coordinate the format of their respective checklists in order to ensure thoroughness, while avoiding duplication of effort.
 - 5. Construction checklists, TAB and startup shall be completed before performance testing can begin.
 - 6. Items of non-compliance in material, installation, or setup shall be corrected in accordance with the contract documents.
 - 7. The contractor ensures that the subcontractors' construction checklists are executed and documented and that startup and initial checkouts are performed. The CxA will verify that the TAB, construction checklists and startup are complete according to approved documents.
 - 8. The CxA develops and implements equipment and system performance test procedures. The forms and procedures are approved by the Owner, GC and A/E.
 - 9. The performance tests are executed by the contractor under the direction of the CxA with the assistance of the facility staff. All documentation is by the CxA. Any testing failure is to be corrected at no additional cost to the Owner, and a re-test is to be performed, observed, and documented.
 - 10. The CxA reviews the O&M documentation for completeness and provides the commissioning record for the O&M manuals.
 - 11. Commissioning should be completed before project turnover is complete.
 - 12. The CxA reviews, pre-approves, and witnesses the training provided by the contractor.

13. Deferred testing is conducted as specified or required.
14. Seasonal testing is conducted to verify that the systems function correctly in opposite seasons.

1.8 COMMISSIONING TEAM

- A. Members appointed by contractors: Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions. The commissioning team shall consist of, but not be limited to, representatives of each contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA.
- B. Members appointed by Owner:
 1. The CxA; designated by the Owner, works with the Owner and the GC to lead, plan, schedule, and coordinate the commissioning team to implement the commissioning process. The Owner will engage the CxA under a separate contract.
 2. Representatives of the facility user's operation and maintenance personnel participate in the commissioning process, as designated by the Owner.
 3. Architect and engineering design professionals.

1.9 RELATED REQUIREMENTS

- A. Other drawings, specifications and submittals, as defined in the construction documents, shall apply to this commissioning program.

1.10 RESPONSIBILITIES

- A. The general responsibilities of various parties in the commissioning process are provided in this sub-section. The specific responsibilities are in the Technical Specifications.
- B. All Parties
 1. Follow the commissioning plan.
 2. Attend initial commissioning meeting and additional meetings as necessary.
 3. Participate in commissioning related activities, as described below.
- C. Architect (A/E)

Construction Phase

1. Attend the commissioning scoping meeting and selected commissioning team meetings.
2. Perform normal submittal review, construction observation, as-built drawing preparation or review, O&M manual review, etc., as contracted.
3. Provide any design narrative documentation requested by the CxA.
4. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
5. Review and approve the O&M manuals.

- D. Engineers of Record

Construction Phase

1. Perform normal submittal review, construction observation, as-built drawing

- preparation or review, etc., as contracted. One site observation should be completed just prior to system startup.
2. Provide any design narrative and sequences documentation requested by the CxA. The designers shall assist (along with the contractors) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed testing procedures.
 3. Attend commissioning scoping meetings and other selected commissioning team meetings.
 4. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
 5. Review and approve the O&M manuals.
 6. Review contractor's red-line drawings.
 7. Review the performance test procedure forms for major pieces of equipment for sufficiency prior to their use.
 8. Witness testing of selected pieces of equipment and systems

Occupancy and Operations Phase

9. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.

E. Commissioning Authority (CxA)

1. The CxA will verify the execution of commissioning process activities using 100 percent sampling. Verification includes, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When testing does not meet the requirements, the CxA will report the failure in the "Commissioning Issues Log."
2. Works with the Owner to coordinate and direct the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
3. Coordinate the commissioning work and, with the GC and Owner, help integrate commissioning activities into the master schedule.
4. Revise the Construction Phase Commissioning Plan as necessary.
5. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
6. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor startup and checkout procedures.
7. Before startup, gather and review the current control sequences and interlocks and work with contractors and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed testing procedures.
8. Review and approve normal contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the A/E reviews.
9. The CxA will provide the contractor with a list of submittals which are to be included in the commissioning submittal review.
10. Write and distribute construction checklists. Prepare and maintain completed

- construction checklist log.
11. Develop an initial systems checkout plan with subcontractors.
 12. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving any discrepancies.
 13. Approve construction checklist completion by selected site observation and spot checking.
 14. Recommend approval of systems startup by reviewing startup reports and by selected site observation.
 15. Review the TAB execution plan.
 16. Recommend approval of air and water systems balancing by spot testing, by reviewing completed reports and by selected site observation.
 17. With necessary assistance and review from installing contractors, write the performance test procedures for equipment and systems, including energy management control system trending, stand-alone data logger monitoring or manual performance testing.
 18. Analyze any performance trend logs and monitoring data to verify performance.
 19. Coordinate, witness, and recommend approval of manual performance tests performed by installing contractors. Coordinate retesting as necessary until satisfactory performance is achieved
 20. Maintain a master Issues Log and a separate testing record. Provide the Owner/ GC with written progress reports and test results with recommended actions.
 21. Review equipment warranties to ensure that the Owner's responsibilities are clearly defined.
 22. Verify training is completed.
 23. Compile and maintain commissioning and building systems records.
 24. Review and approve the preparation of the O&M manuals, if required.
 25. Provide a final commissioning report (as described in this section).
 26. Participate in the development of a systems manual.

Occupancy and Operations Phase

1. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.
2. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning. Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract. Assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.

F. Owner or Owner's Representative (GC)

Construction and Acceptance Phase

1. Facilitate the coordination of the commissioning work by the CxA, and, with the GC and CxA, ensure that commissioning activities are being scheduled into the

master schedule.

2. Review and approve the final Commissioning Plan—Construction Phase.
3. Attend a commissioning scoping meeting and other commissioning team meetings.
4. Perform the normal review of contractor submittals.
5. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
6. Review and approve the performance test procedures submitted by the CxA, prior to testing.
7. When necessary, observe and witness startup and performance testing of selected equipment.
8. Review commissioning progress and deficiency reports.
9. Coordinate the resolution of non-compliance and design deficiencies identified in all phases of commissioning.
10. Sign-off (final approval) on individual commissioning tests as completed and passing. Recommend completion of the commissioning process to the Owner's Project Manager.
11. Assist the GC in coordinating the training of Owner personnel.
12. Provide OPR documentation to the CxA and applicable contractors for information and use.
13. Provide the BOD documents to the CxA and applicable contractors for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.
14. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.

Occupancy and Operations Phase

15. Assist the CxA as necessary in the seasonal or deferred testing and deficiency corrections required by the specifications.

G. Owner's Project Manager (OPM)

Construction Phase

1. Manage the contract of the A/E and of the GC.
2. Arrange for facility operating and maintenance personnel to attend various field commissioning activities and field training sessions.
3. Provide final approval for the completion of the commissioning work.

Occupancy and Operations Phase

4. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.

H. Contractor: Each contractor and their subcontractors and vendors shall assign representatives with expertise and authority to act on their behalf, schedule them to participate in and perform commissioning process activities including, but not limited to, the following:

Construction Phase

1. Facilitate the coordination of the commissioning and incorporate commissioning activities (the Commissioning Plan) into the Overall Project Schedule.
2. Provide detailed startup procedures

3. Include the cost of commissioning in the total contract price.
4. Ensure that all subcontractors and vendors execute their commissioning responsibilities according to the contract documents
5. Provide copies of all submittals as required.
6. Attend and participate in commissioning team meetings, which will be coordinated with the construction meetings.
7. No later than 60 days prior to startup of the first piece of major equipment, meet with the CxA, GC, A/E, OPM and Owner to finalize the detailed commissioning procedures/ schedule.
8. Provide the training of Owner personnel.
9. Review and accept construction checklists provided by the commissioning authority.
10. Complete construction checklists as work is completed and provide to the CxA.
11. Approve that systems have been properly installed, tested, programmed and checked out and are ready for performance testing by the CxA.
12. Accomplish commissioning process test procedures.
13. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
14. Cooperate with the CxA for resolution of issues recorded in the "Issues Log".
15. Prepare O&M manuals, according to the contract documents, including clarifying and updating the original sequences of operation to as-built/as-tested conditions.
16. Provide redlines as necessary for any as-built changes.
17. Review and approve the construction checklists for major pieces of equipment for sufficiency prior to their use.
18. Execute commissioning checklists

Occupancy and Operations Phase

19. Ensure that subcontractors provide assistance for seasonal or deferred performance testing, performed by the CxA, according to the specifications.
20. Ensure that subcontractors correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal testing.
21. Perform all guarantee work for materials furnished under the contract for the time specified in the contract, including all warranties and curing all latent defects within the time period provided in the contract.

I. Vendors/Subcontractors

1. Provide all requested submittal data, including detailed startup procedures and specific responsibilities of the Owner to keep warranties in force.
2. Assist in equipment testing per agreements with subcontractors and/or contractor.
3. Include cost of all special tools and instruments (only available from vendor, specific to a piece of equipment) required for testing, operating, and maintaining equipment according to these contract documents in the bid price to the contractor.
4. Analyze specified products and verify that the A/E has specified the newest, most current equipment reasonable for this project's scope and budget.

5. Provide requested information regarding equipment sequence of operation and testing procedures.
 6. Review construction checklists and test procedures for equipment installed by factory representatives.
- 1.11 COMMISSIONING INTERNATIONAL GREEN CONSTRUCTION CODE (IGCC) REQUIREMENTS
- A. The project must implement practices and procedures to meet the project's environmental goals, which include conforming to the Rhode Island Green Buildings Act 2010. Specific project goals include: use of recycled materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals are implemented to the fullest extent. This commissioning scope includes the requirements for fundamental commissioning.
- 1.12 EQUIPMENT AND SYSTEMS TO BE COMMISSIONED
- A. The following equipment/systems will be commissioned in this project:
 1. All HVAC Systems, Equipment, Devices, and Components
 2. All Control Systems, including Graphics, Displays, Trending & Alarming
 3. Domestic Hot Water Systems
 4. Lighting and Lighting Controls
 5. Electrical Power Distribution Systems

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required performance testing shall be provided by the contractor for the equipment being tested. This includes, but is not limited to, two-way radios, meters, and tools.
- B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration to NIST-traceable standards within the past year to an accuracy of 0.5 degree F and a resolution of + or - 0.1 degree F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

- A. Initial Meeting: Within 90 days of the Notice to Proceed (NTP), the CxA, through the Owner/GC, will schedule, plan and conduct an initial commissioning meeting. The contractor and its responsible parties are required to attend.

- B. Subsequent Meetings: Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution, and planning issues.

3.2 STARTUP, CONSTRUCTION CHECKLISTS, AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment/systems to be commissioned, according to Paragraph 1.12 Equipment and Systems Commissioned.
- B. General: Construction checklists are important to verify that the equipment and systems are fully connected and operational. It ensures that performance testing (in-depth system checkout) may proceed without unnecessary delays. The construction checklists for a given system must be successfully completed and approved prior to startup and formal performance testing of equipment or subsystems of the given system. Contractors are responsible for non-compliance and failed performance tests as a result of inaccurate construction checklists.
- C. Startup and Checkout Plan: The CxA will assist the project commissioning team members responsible for startup of any equipment. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures has been completed. The CxA shall provide construction checklists and startup shall be identified in the commissioning scoping meeting and on the checklist forms.
 - 1. The construction checklists are provided by the CxA. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
 - 2. The contractor shall determine which trade is responsible for executing and documenting each of the line item tasks and transmit the checklists to the responsible subcontractors. Each form may have more than one trade responsible for its execution.
 - 3. The contractor/subcontractor responsible for the purchase of the equipment shall develop the full startup plan by combining the manufacturer's detailed startup and checkout procedures and the construction checklists.
 - 4. The CxA will review and approve the procedures and the documentation format for reporting. The CxA will return the procedures and the documentation format to the contractor, through the GC.
 - 5. The contractor shall transmit the full startup plan to the subcontractors for their review and use.
- D. Sensor and Actuator Calibration: All field-installed temperature, relative humidity, CO, CO₂, refrigerant, O₂, and/or pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated. Verify that all locations are appropriate and away from causes of erratic operation. All test instruments shall have had a certified calibration within the last 6 months to NIST traceable standards, and comply with all local, state and/or federal requirements/certifications, as required. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
- E. Valve and Damper Stroke Setup and Check BAS Readout: Verify 100% valve and damper operations. For all valve and damper actuator positions, verify the actual position against the Building Automation System (BAS) readout. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or

damper is closed and adjust output zero signal as required. Command valve or damper open, verify position is full open and adjust output signal as required. Command the valve or damper to a few intermediate positions. If the actual valve or damper position doesn't reasonably correspond, replace actuator or add pilot positioner (for pneumatics).

- F. Closure for heating coil valves (NO) - Set the heating setpoint 20°F above room temperature. Observe valve open. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set the heating setpoint to 20°F below room temperature. Observe the valve close. For pneumatics, by override in the BAS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.
- G. Closure for cooling coil valves (NC) - Set the cooling setpoint 20°F above room temperature. Observe the valve close. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set the cooling setpoint to 20°F below room temperature. Observe valve open. For pneumatics, by override in the BAS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.
- H. Construction Checklists and Startup.
1. The Contractor shall maintain an ongoing, current project schedule to provide a thirty (30) day look-ahead of key project milestones to all project team members, including the CxA.
 2. At least (10) working days prior to the scheduled startup, the contractor shall coordinate startup and checkout with the GC, A/E, and CxA. The execution and approval of the construction checklists, startup, and checkout shall be directed and performed by the contractor, subcontractor or vendor. Signatures are required of the applicable subcontractors for verification of completion of their work.
 3. The subcontractors and vendors shall execute startup and provide the CxA and A/E, through the Owner/GC, with a signed and dated copy of the completed startup and construction checklists.
 4. Only individuals of the contractor (technicians, engineers, tradesmen, vendors, etc.) who have direct knowledge and witnessed that a line item task on the construction checklist was actually performed shall check off that item. It is not acceptable for witnessing supervisors to fill out these forms.
 5. Construction checklists must be completed, signed, and dated prior to the CxA commencing functional testing.

<p><u>CHECKLIST SIGN-OFF:</u> Signoff of this form constitutes approval from the Contractor and OPM that the equipment has been properly installed, started up, contractor tested and is fully ready for functional demonstration as specified in the project specifications and submittals. The Contractor and OPM accept responsibility for retesting if the systems are found to be incomplete. The signoff MUST be completed prior to the functional testing phase of commissioning.</p>			
Company	Contact Name	Contact Signature	Date
Contractor			
OPM			

I. Deficiencies, Non-Conformance, Checklist Approval and Startup (Master Issues Log).

1. The contractor shall ensure that the subcontractors clearly list any outstanding items of the initial startup and construction checklist procedures that were not completed successfully, on an attached sheet. The form and any outstanding deficiencies shall be provided, through the Owner/GC, to the CxA within two days of test completion.
2. The CxA will review the report and issue either a non-compliance report or an approval form, through the GC, to the contractor. The installing subcontractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, shall notify the Owner/GC as soon as outstanding items have been corrected, and resubmit an updated startup report with a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA will recommend approval of the execution of the checklists and startup of each system.
3. Items left incomplete that later cause deficiencies or delays during performance may result in back charges to the contractor.

3.3 SUBMITTALS

- A. The CxA will provide appropriate contractors with a specific request for the types of submittal documentation the CxA requires for the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer's printed installation and detailed startup procedures, full sequences of operation, O&M data, performance data, any performance test procedures, control drawings and details of Owner contracted tests. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the commissioning authority. All documentation requested by the CxA will be included by the subcontractors in their O&M manual contributions.
- B. The CxA will review submittals related to the commissioned equipment for conformance to the contract documents as it relates to the commissioning process, to the

performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance procedures and only secondarily to verify compliance with equipment specifications. The commissioning authority will notify the Owner/GC, OPM or A/E as requested, of items missing or areas that are not in conformance with contract documents and which requires resubmission.

- C. The CxA may request additional design narrative from the A/E and controls contractor, depending on the completeness of the OPR documentation and sequences provided with the specifications.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the contractor, though the CxA will review and approve them.

3.4 PHASED COMMISSIONING

- A. If the project requires TAB, startup and performance testing to be executed in phases. Phasing shall be coordinated with the Owner/GC and CxA and be reflected in the overall project schedule and commissioning schedule by the contractor. Final performance testing of all systems will be as required by the phasing plan. Final performance testing of completed systems shall be performed before final turnover of the entire project.

3.5 PERFORMANCE TESTING

- A. Requirements: The performance testing shall demonstrate that each system is operating according to the documented design intent and contract documents. Performance testing facilitates bringing the systems from a state of individual substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems. Performance testing only commences after the contractors have declared the systems and sequence of operations have been started, programmed, tested and checked out. Signing of the construction checklist is the declaration that the systems are ready for performance testing by the CxA.
- B. Coordination and Scheduling: The contractor shall provide sufficient notice, regarding their completion schedule for the construction checklists and startup of all equipment and systems to allow the performance testing to be scheduled. The commissioning team shall oversee, witness, and document the performance all equipment and systems. The CxA in association with the contractor/subcontractors and facility staff shall execute the tests. Performance testing shall be conducted after the construction checklists, and startup has been satisfactorily completed. The control system shall be sufficiently tested and approved by the CxA before it is used, to verify performance of other components or systems. The air balancing and water balancing shall be completed before performance testing of air or water-related equipment or systems. Testing proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be checked.
- C. Development of Test Procedures: Before test procedures are finalized, the contractor shall provide to the A/E and the CxA all requested documentation and a current list of changes affecting equipment or systems, including an updated points list, program code, control sequences, and testing parameters. Using the testing parameters and

requirements in the technical specifications, the CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each contractor, subcontractor or vendor, as appropriate, shall provide assistance to the CxA in developing the final procedures. Prior to finalization, the A/E will review and concur with the test procedure.

D. Test Methods.

1. Performance testing and verification may be achieved by manual testing or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CxA may substitute specified methods or require an additional method to be executed other than what was specified, with the approval of the A/E and Owner/GC. The CxA will determine which method is most appropriate for tests that do not have a specified method.
2. Simulated Conditions. Simulating conditions shall be allowed, though timing the testing to experience actual conditions is encouraged wherever practical.
3. Overridden Values. Overriding sensor values to simulate a condition, such as overriding the outside air temperature reading in a control system to be something other than it really is, is acceptable.
4. Simulated Signals. Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overridden values.
5. Altering Setpoints. Rather than overriding sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.
6. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the test parameters, that the indirect readings through the control system represent actual conditions and responses.
7. Setup. Each performance test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The contractor/subcontractor(s) assisting the CxA in executing the test shall provide all necessary materials, system modifications, etc., to produce the necessary flows, pressures, temperatures, etc., necessary to execute the test according to the specified conditions. At completion of the test, the contractor/subcontractor(s) shall return all affected equipment and systems to their approved operating settings.

3.6 DOCUMENTATION AND APPROVAL OF PERFORMANCE TESTS

- A. Documentation: The CxA shall witness and verify/pre-approve the documentation of the results of all performance tests. The CxA shall complete all documentation for performance testing.
- B. Non-Conformance:
 1. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form or on an attached sheet.
 2. As tests progress and a deficiency are identified, the CxA will discuss the issue with the commissioning team and the contractor.

- a. When there is no dispute on the deficiency and the contractor accepts responsibility to correct it:
 - (i) The CxA will document the deficiency and the contractor's response and intentions. After the day's work, the CxA will submit the non-compliance reports to the GC. The contractor corrects the deficiency, signs the statement of correction at the bottom of the non-compliance form certifying that the equipment is ready to be retested and sends it back to the CxA.
 - (ii) If the failure rate of a similar family of equipment or devices is greater than 10%, then the Owner shall be notified. The matter shall be addressed by the Owner, GC, CxA, and other applicable parties. The failure issue shall be resolved to the Owner's satisfaction.
 - (iii) The contractor shall reschedule the test; and the test repeated.
- b. If there is a dispute about a deficiency, regarding whether or not it is a deficiency:
 - 1) Disputes shall be documented on the non-compliance form with the contractor's response.
 - 2) Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed.
 - 3) The A/E will have final interpretive authority.
 - 4) The Owner will have final acceptance authority.
 - 5) The CxA will document the resolution process.
 - 6) Once the interpretation and resolution have been decided, the contractor shall correct the deficiency, signs the statement of correction on the non-compliance form and provides it to the CxA, through the GC. The contractor shall reschedule the test and the test repeated until satisfactory performance is achieved.
3. The contractor shall assume the costs of repeating performance tests.
4. The contractor shall submit in writing to the GC at least as often as commissioning meetings are being scheduled, the status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.
 - a. The CxA retains the original non-conformance forms until the end of the project.
 - b. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the contractor.
- C. Product Defects: Manufacturing defects shall be identified by the contractor during testing and checkout. If 10% (or three, whichever is greater) of identical pieces of equipment fail to meet submitted performance specifications due to a manufacturing defect, the A/E or CxA may consider all identical units unacceptable. In such case, the contractor shall provide the Owner with the following:
 1. Within one week of notification from the Owner/GC, the contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the GC within two weeks of the original notice.

2. Within two weeks of the original notification, the contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc., and all proposed solutions. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
 3. The A/E will determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples, where applicable, of the proposed solution shall be installed by the contractor and the A/E shall be allowed to test the installations for up to one week, upon which the A/E will decide whether to accept the solution.
 5. Upon acceptance, the contractor or manufacturer shall replace or repair all identical items, at their expense. Corrective work shall proceed with reasonable speed beginning within one week from when parts are obtained.
- D. Approval: The CxA notes each satisfactorily demonstrated function on the test form. Final approval of the performance test by the Owner is made after review by the CxA and GC, following recommendations by the A/E.

3.7 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the project completion level, required occupancy condition or other deficiency, execution of checklists and performance testing may be delayed upon approval of the CxA and GC. These tests shall be conducted in the same manner as the seasonal tests as soon as possible. Services of necessary parties shall be negotiated.
- B. Seasonal Testing: During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity through the Owner/GC. Tests shall be executed, documented by the CxA and deficiencies should be corrected by the appropriate contractor/ subcontractors with the CxA witnessing. Any final adjustments to the O&M manuals and as-builts due to the testing shall be made by the contractor.

3.8 TRAINING OF OWNER PERSONNEL

- A. The contractor shall provide training coordination, scheduling of subcontractors, and ensure that training is completed. All training shall be coordinated, through the GC, with the CxA witnessing activities.
- B. The contractor shall ensure that each subcontractor and vendor shall have the following responsibilities:
 1. Furnish the CxA through the GC a training plan sixty (60) days before the planned training covering the following elements:
 - a. Equipment
 - b. Intended audience
 - c. Location of training
 - d. Objectives
 - e. Description of Subjects covered
 - f. Duration of training on each subject
 - g. Instructor for each subject
 - h. Methods, including but not limited to, classroom lectures, manufacturer-quality videos, site walk-throughs, operational demonstrations, and written handouts.

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of equipment that makes up the system.
 3. Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.
 4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated at another scheduled time, if necessary.
 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
 6. The controls contractor shall attend sessions other than the controls training, as specified, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 7. The training sessions shall follow the outline in the table of contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
 8. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the O&M manuals.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. Classroom sessions shall include the use of overhead projections, slides, video- and audio-taped material as might be appropriate.
 - i. Hands-on training shall include startup, operation in all modes possible, including manual, shut-down, alarms, power failure and any emergency procedures, and preventative maintenance for all pieces of equipment.
- C. The contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls not controlled by the central control system.
- D. All training sessions with the Owner's personnel shall be professionally digitally video recorded by trade (mechanical, electrical and plumbing) and a DVD provided with the O&M manuals.
- E. At the discretion of the CxA, training may occur before performance testing is complete if required by the facility operators to assist the CxA in the performance testing.

3.9 OPERATIONS AND MAINTENANCE MANUALS

- A. The commissioning process requires detailed O&M documentation as identified in this section and technical specifications.
- B. Contractor shall submit two draft copies of the complete operating and maintenance manual to the GC for review by the architect/engineer and CxA within 60 calendar days after review of equipment shop drawings. One copy will be returned to the contractor within 30 days after receipt by the A/E.
- C. Contractor shall submit corrected final approved manuals prior to substantial completion. Prior to final submittal, the CxA shall review the O&M manuals (in addition to the initial draft O&M manual), and documentation, with redline as-builts, for systems that were commissioned to verify compliance with the specifications. The CxA will communicate, through the GC, deficiencies in the manuals to the contractor or A/E, as requested. Upon a successful review of the corrections, the CxA will recommend approval and acceptance of these sections of the O&M manuals to the GC. The CxA will also review each equipment warranty and verify that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's contract.
- D. The contractor shall compile O&M manuals for every piece of equipment and building operating or electrical system being commissioned in accordance with the project general requirements.
- E. Commissioning Report
 - 1. The CxA will provide the Owner with a Final Commissioning Report in both hard-copy and electronic format.

END OF SECTION

SECTION 22 08 00 – PLUMBING COMMISSIONING REQUIREMENTS

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. In addition to the drawings and general provisions of the contract, commissioning requirements are defined in the following sections:
 - 1. Section 019100 – General Commissioning Requirements
 - 2. Section 230800 – HVAC Commissioning Requirements
 - 3. Section 239010 – BAS Commissioning Requirements
 - 4. Section 260800 – Electrical Commissioning Requirements

1.2 SUMMARY

- A. This section includes commissioning process requirements for Plumbing systems, assemblies, and equipment.
- B. General commissioning requirements are described in Division 01 Section 019100 and are therefore not repeated in this Section.

1.3 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of the plumbing systems shall include, but are not limited to:
 - 1. The incoming domestic water service, including backflow preventers and meters
 - 2. Domestic water recirculating pumps
 - 3. Fuel-fired domestic storage-type water heaters and expansion tanks
 - 4. Sample testing of plumbing fixtures
 - 5. Controls associated with the above systems
 - 6. Review other systems such as pumps and ejectors, vacuum system, etc.

1.4 SUBMITTALS

- A. Refer to Division 01 Section 01330 “Submittal Procedures” for specific requirements.
- B. In addition, provide the following:
 - 1. Certificates of readiness
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. O&M manuals
 - 4. Contractor and equipment startup and test reports
 - 5. Completed construction checklists

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall furnish all standard testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested. For example, the plumbing contractor of Division 22 shall ultimately be responsible for all standard testing equipment for the plumbing system in Division 22, except for equipment specific to and used by TAB in their commissioning responsibilities. A sufficient quantity of two-way radios shall be provided by each subcontractor.
- B. Refer to Division 01 Section 019100 “General Commissioning Requirements” for a detailed description of test equipment requirements.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Construction Checklists for all commissioned components, equipment, and systems.
- B. Red-lined and As-Built Drawings
 - 1. The contractor shall verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 - 2. Preliminary red-lined drawings must be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 - 3. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.
 - 4. The contracted party, as defined in the Contract Documents shall create the as-built drawings.
 - 5. All red-lined drawings are to be available on-site for review by the Owner and the CxA.

3.2 COMMISSIONING TEAM RESPONSIBILITIES

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for commissioning team member roles and responsibilities.

3.3 TESTING PREPARATION

- A. Certify in writing to the CxA that plumbing systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

- B. Certify in writing to the CxA that Plumbing instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. If the failure rate of a similar family of equipment or devices is greater than 10%, the Owner shall be notified. The matter shall be addressed by the Owner, GC, CxA, and other applicable parties. The failure issue shall be resolved to the Owner's satisfaction.

3.4 DOMESTIC WATER BALANCING VERIFICATION

- A. Prior to performance of Domestic Water Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least ten (10) days in advance of testing and balancing work, and provide access for the CxA to witness balancing work.

3.5 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Plumbing testing shall include entire Plumbing installation. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA and the Plumbing and Balancing contractors shall prepare detailed testing plans, procedures, and checklists for Plumbing systems, subsystems, and equipment.
- E. Tests shall be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing

instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Plumbing system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 TESTING PROCEDURES

A. General

- 1. Refer to individual Division 22 sections for testing and acceptance procedure requirements. Provide the CxA with submittals, test data, inspector records, and certifications.
- 2. Provide technicians, instrumentation, tools, and equipment to test performance of air, fuel gas, sanitary waste and vent piping, storm drainage piping, sprinkler and domestic water distribution systems.

B. Plumbing Contractor shall prepare and execute a pipe system cleaning, flushing, and hydrostatic testing plan for all distribution systems. Plans shall include the following:

- 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
- 2. Description of equipment for flushing operations.
- 3. Minimum flushing water velocity.
- 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

C. The Plumbing Contractor shall plan and execute performance testing of vibration isolation and seismic controls. Furnish technicians, instrumentation, tools, and equipment to test performance.

3.7 DEFICIENCIES

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deficiencies, non-conformances, cost of retesting, or failures due to manufacturer defects.

3.8 APPROVALS

- A. Refer to Division 01 Section “General Commissioning Requirements” for approval procedures.

3.9 DEFERRED TESTING

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.10 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to operation and maintenance manuals.

3.11 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section “General Commissioning Requirements” for requirements pertaining to training.

- B. The contractor shall provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of Plumbing equipment.

1. If a system fails during demonstrations to perform in accordance with the requirements of the O&M manual or sequence of operations, the Contractor shall repair or adjust the system as necessary and the demonstration repeated.
2. The Contractor shall provide one or more qualified instructors as appropriate to the equipment or systems. The instructor may be the start-up technician for the piece of equipment, the installing contractor or manufacturer’s representative. The instructor shall possess practical expertise and in-depth knowledge of all modes of operation for each specific piece of equipment.
3. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
4. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
5. The plumbing contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls.
6. Training shall occur after functional testing is complete, unless approved otherwise by the Owner.

7. All training sessions with the Owner's personnel shall be professionally digitally video recorded by trade (mechanical, electrical plumbing) and a DVD provided with the O&M manuals.

END OF SECTION 220800

SECTION 230800 – HVAC COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Specification Sections, apply to this commissioning requirement.
- B. In addition to the drawings and general provisions of the contract, commissioning requirements are defined in the following sections:
 - 1. Section 019100 – General Commissioning Requirements
 - 2. Section 220800 – Plumbing Commissioning Requirements
 - 3. Section 239010 – BASystem Commissioning Requirements
 - 4. Section 260800 – Electrical System Commissioning Requirements

1.2 SUMMARY

- A. This section defines commissioning requirements for HVAC&R (Heating, Ventilation, Air-conditioning and Refrigeration) systems, assemblies, and equipment.
- B. General commissioning requirements are described in Division 01 Section 019100 and are therefore not repeated in this Section.

1.3 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of the HVAC&R systems shall include all equipment and components associated with the Heating, Ventilation, Air-Conditioning and Refrigeration systems. These shall include, but are not limited to:
 - 1. Air Handling Units
 - 2. Split System Air Conditioning
 - 3. Shutoff VAV Terminal Boxes
 - 4. Heating Hot Water Coils
 - 5. Airflow Control Valves
 - 6. Dampers, Ductwork, Diffusers and Filters.
 - 7. General Duty and Environmental Air Exhaust Fans
 - 8. Pumps, Piping, Valves and Strainers
 - 9. Glycol Makeup Units
 - 10. Unit Heaters
 - 11. Expansion Tanks and Air Separators
 - 12. Energy Recovery Systems including Pumps and Heat Exchangers
 - 13. Water-Cooled Chillers and Chilled Beams
 - 14. Steam and Condensate
 - 15. All controls, including operator stations, displays, alarms, sensors and control systems programming.

1.4 SUBMITTALS

- A. Refer to Division 01 Section 013300 “Submittal Procedures” for specific requirements.
- B. In addition, provide the following:
 - 1. Certificates of readiness.
 - 2. Certificates of completion of installation, prestart, and startup activities.
 - 3. O&M manuals.
 - 4. Contractor and equipment vendor startup and test reports.
 - 5. Completed construction checklists.
- C. Control Drawings Submittals
 - 1. The control drawings shall have a key to all abbreviations.
 - 2. The control drawings shall contain graphic schematic depictions of the systems and each component.
 - 3. The diagrams shall include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - 4. Provide a full points list with at least the following included for each point:
 - a. Controlled system
 - b. Point abbreviation
 - c. Point description
 - d. Display unit

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall furnish all standard testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested. For example, the mechanical contractor of Division 23 shall ultimately be responsible for all standard testing equipment for the HVAC&R system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities. A sufficient quantity of two-way radios shall be provided by each sub-contractor.
- B. Refer to Division 01 Section 019100 “General Commissioning Requirements” for a detailed description of test equipment requirements.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Construction Checklists for all commissioned components, equipment, and systems.
 - 1. The CxA will develop checklists CxA and provide to the contractors.
 - 2. Contractors shall complete the construction checklists and provide completed copies to the CxA prior to beginning system functional testing.

- B. Red-lined and As-Built Drawings
 - 1. The contractor shall verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 - 2. Preliminary red-lined drawings shall be made available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 - 3. The Contractor shall incorporate changes resulting from Functional Testing into the final as-built drawings, which will be created from the red-lined drawings.
 - 4. The contracted party, as defined in the Contract Documents, shall create the As-Built drawings.
 - 5. All red-lined drawings shall be available for review on-site by the Owner and the CxA.

- C. Operation and Maintenance Data
 - 1. Contractor shall provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
 - 2. The CxA will review the O&M literature once for conformance to project requirements.
 - 3. The CxA shall receive a copy of the final approved O&M literature after the Contractor has made final corrections.
 - 4. Review data in O&M Manuals.

- D. Systems Manual Requirements:
 - 1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
 - 2. The GC shall include final approved versions of the following information for the Systems Manual:
 - a. As-Built System Diagrams
 - b. Verified Record Drawings
 - c. Test Results not otherwise included in Cx Record
 - d. Periodic Maintenance Information for computer maintenance management system

- e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - g. Training Records, Information on training provided, attendees list, and any on-going training
- 3. This information shall be organized and arranged by building system, such as fire alarm, chilled water, heating hot water, etc.
 - 4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

3.2 COMMISSIONING TEAM RESPONSIBILITIES

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for commissioning team member roles and responsibilities.

3.3 TESTING PREPARATION

- A. Certify in writing to the CxA that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested, including but not limited to, normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions.
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. The contractor shall install testing and measuring instruments and logging devices to record test data as directed by the CxA.
- H. If the failure rate of a similar family of equipment or devices is greater than 10%, then the Owner shall be notified. The matter shall be addressed by the Owner, GC, CxA, and other applicable parties. The failure issue shall be resolved to the Owner’s satisfaction.

3.4 TESTING, ADJUSTING AND BALANCING VERIFICATION

- A. Prior to performance of Testing, Adjusting and Balancing work, provide copies of reports, sample forms, checklists, and certificates to the CxA.
- B. Notify the CxA at least ten (10) days in advance of testing and balancing work, and provide access for the CxA to witness testing and balancing Work.
- C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
 - 1. The CxA will notify testing and balancing subcontractor ten (10) days in advance of the date of field verification. Notice will not include data points to be verified.
 - 2. The testing and balancing subcontractor shall use the same instruments by model and serial number that were used when original data were collected.
 - 3. Failure of an item is defined by a deviation of more than 10 percent of any pertinent variable other than sound. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise shall be considered.
 - 4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.5 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the HVAC&R contractor, testing and balancing Subcontractor, and HVAC&R Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.
- E. Tests shall be performed using design conditions whenever possible.
- F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 TESTING PROCEDURES

- A. Testing requirements are specified in individual Division 23 sections. Provide the CxA with submittals, test data, inspector records, and certifications as required.
- B. Test requirements for pipe system cleaning, flushing, hydrostatic tests, and chemical treatment: are specified in Division 23 Hydronic Piping section. HVAC&R Contractor shall prepare a pipe system cleaning, flushing, and hydrostatic testing plan. Provide the CxA with cleaning, flushing, testing, and treating plan and final reports. Plan shall include the following:
 - 1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed to Drawings for each pipe sector, showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.
 - 2. Description of equipment for flushing operations.
 - 3. Minimum flushing water velocity.
 - 4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.
- C. Provide qualified refrigeration system technicians, instrumentation, tools, and equipment to test performance of chillers, condensing sections of all packaged equipment and heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.
- D. Provide qualified technicians, instrumentation, tools, and equipment to test performance of air and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal and unitary equipment.
- E. Provide qualified technicians, instrumentation, tools, and equipment to test performance of acoustic, vibration isolation, and seismic controls.

3.7 DEFICIENCIES

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to deficiencies, non-conforming conditions, cost of retesting, or failure due to manufacturing defects.

3.8 APPROVAL

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for approval procedures.

3.9 DEFERRED TESTING

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.10 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for operation and maintenance manual requirements.

3.11 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for owner training requirements.
- B. The Mechanical Contractor shall provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of mechanical equipment.
 - 1. A complete training plan and schedule shall be submitted by the Contractor to the CxA four (4) weeks prior to any training.
 - 2. A training agenda for each training session shall be submitted to the CxA one (1) week prior the training session.
 - 3. The CxA shall be notified at least (72) hours in advance of scheduled tests so that testing may be observed by the CxA and Owner's representative. A copy of the test record shall be provided to the CxA, Owner, and Architect.
 - 4. The contractor shall engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
 - 5. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
 - 6. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, heat exchangers, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems.

7. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including but not limited to startup, shutdown, fire/smoke alarms, and power failures.
8. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated.
9. The Contractor shall provide one or more qualified instructors as appropriate to the equipment or systems. The instructor may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. The instructor shall possess practical expertise and in-depth knowledge of all modes of operation for each specific piece of equipment.
10. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
11. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
12. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns. Include Material Safety Data Sheets as applicable.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
 - h. The format and training agenda in The HVAC Commissioning Process, ASHRAE Guideline 1-2007, is recommended.
13. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventive maintenance for all pieces of equipment.
14. The mechanical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls not controlled by the central control system.
15. Training shall occur after functional testing is complete, unless approved otherwise by the Owner.

16. All training sessions with the Owner's personnel shall be professionally digitally video recorded by trade (mechanical, electrical, plumbing) and DVD provided with the O&M manuals.
- C. The Controls Contractor shall provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of mechanical equipment.
1. Provide the CxA and AE with a training plan four weeks before the planned training.
 2. The Controls Contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to instruct the Owner on all the capabilities of the control system clearly and completely.
 3. The Instructors shall furnish the standard operating manual for the systems and any special training manuals for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual shall be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals shall cover all control sequences and have a definitions section that fully describes all relevant words and abbreviations used in the manuals and in all software displays. Manuals shall be approved by the CxA and AE. The Contractor shall deliver all copies of audiovisual materials to the Owner.
 4. Training sessions shall be tailored to the needs and skill levels of the trainees. Trainers shall be knowledgeable on the system and its use in buildings. The contractor shall employ the most qualified trainers for the on-site sessions. The Owner will approve the instructor prior to scheduling the training.
 5. Should the system fail to perform in accordance with the requirements of the O&M manuals or sequences of operations during any demonstration, the system shall be repaired or adjusted as necessary and the demonstration repeated.
- D. The TAB contractor shall have the following training responsibilities:
1. TAB shall meet for 4 hours with facility staff after completion of TAB and instruct them on the following:
 - a. Review the final TAB report, explaining the layout and meanings of each data type.
 - b. Discuss any outstanding deficiencies in control, ductwork, piping or system design that may affect the proper delivery of air or water.
 - c. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
 - d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 - e. Other salient information that may be useful for facility operations, relative to TAB.

END OF SECTION 230800

SECTION 230993

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

- A. The General Provisions of the Contract, including General and Supplementary Conditions and General Requirements, apply to the work specified in this Section.
- B. The General Requirements in Sections 200050 shall also govern the work under this Section.
- C. Examine all drawings and data and coordinate the work of the Section with all related and adjoining work.
- D. Refer to section 239010, Commissioning of Integrated Automation requirements for work related to this section.

1.2 SUMMARY

- A. This Section includes control sequences for HVAC systems, subsystems, and equipment.
- B. Controls shall interfere seamlessly with the campus wide Energy Management System. Controls shall be by InControl Inc.

1.3 DEFINITIONS

- A. DDC: Direct Digital Control
- B. VAV: Variable Air Volume

1.4 HOT WATER CONTROL

- A. Hot Water Control:
 - 1. Heating Hot water Pump Control:
Whenever the outside air temperature is 65°F or below, or there is a call for heat at o the AHU heating coil or other heating terminal, the heating hot water pump P-1 shall be enabled.

1.5 VARIABLE VOLUME PACKAGED ROOFTOP AIR HANDLING UNIT

- A. Optimal Start Mode
 - 1. The zone will calculate how long it will take to return from its unoccupied state to its occupied setpoint based on the heating or cooling capacity and the outside air temperature. The zone will then adjust its effective setpoint for the time necessary to ensure the desired zone conditions at occupancy.

2. The system will not start more than 4 hours before a scheduled occupancy.

B. Occupied Stand-By Mode

1. The unit's supply and return fans are enabled subject to the unit safeties.
2. When the unit starts, the outside air damper shall remain closed.
3. If the supply or return fan fails to start, as sensed by its respective current sensor, both fans shall be stopped and an alarm shall be indicated at the head end.
4. A discharge sensor shall maintain its setpoint by modulating the 3-way heating coil valve (valve shall be normally open)
5. Whenever the coil valve is open to the coil, or the outside air temperature is below 38°F (adj.), the freeze pump, P-2, shall operate.
6. If the low temperature thermostat senses a temperature below its setpoint, the economizer dampers shall position to close off the outside air, the heating valve shall open full, the freeze pump (if not running) shall start, the supply and return fans shall stop, and an alarm shall be indicated at the head end.
7. On a call for cooling, the discharge sensor will first utilize the economizer for free cooling, as long as the supply air temperature is 2°F cooler than the space setpoint and the outside air enthalpy is less than 22 Btu/lb (adj.). When the economizer can no longer maintain these conditions, the DX Cooling shall be enabled and the economizer dampers shall closed to their minimum position (only when cooling is available).
8. Supply and return air fans shall modulate to maintain desired duct pressure.

C. Occupied Mode

1. The occupancy mode shall be determined by an auxiliary set of contacts from an occupancy sensor. (Note: The occupancy sensor shall be furnished, mounted, and wired by the Temperature Control Contractor)
2. The unit's supply and return fans shall continue to operate subject to the unit safeties.
3. The outside air damper shall open to it's minimum position.
4. If the supply or return fan fails to start, as sensed by its respective current sensor, both fans shall be stopped and an alarm shall be indicated at the head end.
5. A discharge sensor shall maintain its setpoint by modulating, in sequence, the 3-way heating coil valve and the economizer dampers beyond their minimum position.

6. The discharge air sensor's setpoint shall be reset by the space sensor.
7. If the mixed air temperature drops below 55°F (adjustable), the economizer dampers will begin to close.
8. When the discharge sensor has a call for heating, the economizer dampers shall return to their minimum position and the heating valve shall modulate open.
9. Whenever the coil valve is open to the coil, or the outside air temperature is below 38°F (adj.), the freeze pump (P-2) shall operate.
10. If the low temperature thermostat senses a temperature below its setpoint, the economizer dampers shall position to close off the outside air, the heating valve shall open full, the freeze pump (if not running) shall start, the supply and return fans shall stop, and an alarm shall be indicated at the head end.
11. On a call for cooling, the discharge sensor will first utilize the economizer for free cooling, as long as the supply air temperature is 2°F cooler than the space setpoint and the outside air enthalpy is less than 22 Btu/lb (adj.). When the economizer can no longer maintain these conditions, the DX cooling shall be engaged and the economizer dampers shall closed to their minimum position (only when cooling is available).
12. A CO2 detector provided by this contractor, located in the space, shall gradually modulate the economizer dampers open to the outside air to maintain the maximum CO2 setpoint (1000ppm adjustable). The discharge air setpoint shall be maintained by modulating the heating coil valve.

D. Unoccupied Mode

1. The supply fan shall be cycled on full heat and 100% return air, with 120°F (adj.) discharge air temperature, to maintain a reduced unoccupied heating temperature space setpoint.
2. The supply fan shall be cycled on 100% return air and cooling to maintain the unoccupied cooling space setpoint of 85°F (adj.).

E. Demand ventilation control:

During the occupied mode, on a rise in return air CO2 above 1000 PPM (adjustable), over a period of 10 minutes (adjustable) if after this period the CO2 level has not dropped, then the economizer dampers shall continue to modulate open up to the maximum position listed in the schedule, subject to a mixed air limit sensor. After the indoor CO2 concentration dropped below 600ppm (adjustable), the outside air damper shall return to it's min position. This contractor shall provide outdoor CO2 sensor. The CO2 concentration shall be the difference between indoor and outdoor concentration. When the CO2 concentration in the space exceeds 100ppm, an alarm shall be generated at the head-end.

1.6. TYPICAL VAV BOX WITH HOT WATER REHEAT

A. Occupied

1. As the space temperature rises above the cooling setpoint, the VAV box shall modulate to its maximum CFM. As the space temperature falls below the cooling setpoint, the VAV box shall modulate to its minimum cooling CFM. Upon a further decrease in space temperature, the VAV box will modulate to the minimum heating CFM. The hot water valve will modulate open.

B. Unoccupied

1. The VAV box actuator shall be open fully.

1.7. UNIT VENTILATOR CONTROL (with direct outside air)

A. Occupied Mode (stand-by)

1. The supply fan shall start and run continuously, subject to the unit safeties. If the supply fan should fail, as sensed by a current switch, an alarm shall be indicated at the operator workstation. System shall be indexed occ/unocc by the optimal start program in the EMS system.
2. When the fan starts, the fresh air dampers shall remain closed.
3. When the space temperature falls below its heating setpoint and the outside air is below 68°F (adjustable) the space sensor will modulate the heating/cooling coil valve to maintain its temperature setpoint.
4. When the space temperature rises above its cooling setpoint and the outside air is above 68°F (adjustable) the space sensor will modulate the DX cooling to maintain temperature setpoint (only when cooling is available).
5. Occupancy shall be determined by an wall mounted occupancy sensor furnished and installed by this contractor.

B. Occupied Mode

1. The supply fan shall start and run continuously, subject to the unit safeties. If the supply fan should fail, as sensed by a current switch, an alarm shall be indicated at the operator workstation. System shall be indexed occ/unocc by the optimal start program in the EMS system. When the units are in the occupied mode, the damper on the common fresh air intake shall open fully.

2. When the fan starts, the minimum outside air damper associated with the unit, shall open to its min position. OA Damper shall modulate to maintain CO2 levels in the space below set point (1000ppm, adjustable). Wall mounted CO2 sensors shall be provided by this Contractor.
3. When the space temperature falls below its heating setpoint and the outside air is below 68°F (adjustable) the space sensor will modulate the heating/cooling coil valve to maintain its temperature setpoint.
4. A low limit thermostat, located after the heating coil, shall stop the supply fan, open the heating coil valve full, close the outside air damper, and indicate an alarm at the head end upon sensing a temperature below its setpoint of 38°F (adj.).
5. On a call for cooling, the heating valve shall close, the discharge sensor will first utilize the economizer for free cooling, as long as the supply air temperature is 2°F cooler than the space setpoint and the outside air enthalpy is less than 22 Btu/lb (adj.).
When the economizer can no longer maintain these conditions, the DX cooling shall be enabled and the economizer dampers shall closed to their minimum position (only if cooling is available).

C. Unoccupied Mode

1. The supply fan shall be cycled on full heat and 100% return air, with 120°F (adj.) discharge air temperature, to maintain a reduced unoccupied heating temperature space setpoint.
2. The supply fan shall be cycled on full cooling and 100% return air to maintain the unoccupied cooling space setpoint of 85°F (adj.).

1.8. EXHAUST FAN CONTROL

- A. The exhaust fans shall operate during the occupied period and remain off during the unoccupied period. If the exhaust fan should fail, as sensed by a current sensor, and alarm shall be indicated at the head end.
- B. Transfer Air Fans associated with the toilet room exhaust shall run all the time, when the building is in the occupied mode.
- C. This Contractor shall provide reverse acting thermostat, to control the exhaust fans located in stairs, mechanical rooms and outdoor storage. Fans shall start every time the temperature in the space exceeds 85deg F (adjustable).

1.9 RADIATAT PANEL CONTROL

- A. A space sensor shall cycle the low voltage 2-position spring return, normally open, radiation valve in order to maintain it's occupied and unoccupied setpoint.

1.10 EXISTING AIR HANDLING UNIT

A. Optimal Start Mode

1. The zone will calculate how long it will take to return from its unoccupied state to its occupied setpoint based on the heating or cooling capacity and the outside air temperature. The zone will then adjust its effective setpoint for the time necessary to ensure the desired zone conditions at occupancy.
2. The system will not start more than 4 hours before a scheduled occupancy.

B. Morning Warm Up Mode:

The supply fan is commanded on. The fan shall operate on 100% return air and the heating coil valve opens full to the coil to bring the space up to the occupied setpoint of 70 degrees F (adjustable) as occupancy is scheduled to occur. Whenever the outside air is below 35 degrees F (adjustable) or the valve is open to the coil, the secondary circulator shall operate. If the pump status is not verified by the current sensor then an alarm will be indicated at the head end computer. If the supply fan fail to start in any mode of operation, as determined by the current sensor, an alarm shall be indicated at the head end and fan shall be commanded off.

C. Cool Down Mode:

The supply fan are commanded on. The heating valve shall close, the circulating pump shall stop, when outside air temperature permits, the discharge temperature sensor will first utilize the economizer for free cooling, as long as the supply air temperature is 2°F cooler than the space setpoint and the outside air enthalpy is less than 22 Btu/lb (adj.). When the economizer can no longer maintain these conditions, the DX cooling shall be enabled and the economizer dampers shall close (only if cooling is available). If the supply fan fail to start in any mode of operation, as determined by current sensors, an alarm shall be indicated at the head end and fan shall be commanded off.

D. Occupied Heating (occupancy sensors provided by this contractor senses motion – eight sensors; 4 wall mounted and 4 ceiling mounted):

The supply and return fans shall continue to run. The economizer dampers open to their minimum positions and the unit discharge sensor shall maintain its setpoint by modulating the heating coil valve. Whenever the outside air is below 35 degrees F (adjustable) or the valve is open to the coil, the secondary circulator shall operate. If the pump status is not verified by the current sensor then an alarm will be indicated at the head end computer. A low temperature protection thermostat located in the heating coil discharge shall stop the unit fan, close the outside damper, open the coil valve full to the coil and indicate an alarm at the head end upon sensing a temperature below its setpoint. When the OA damper opens the roof mounted exhaust fan EF-1 shall start on low speed. As the OA damper opens more than 30% to allow for more OA, the EF-1 shall run on full speed. When the OA damper opens more than 50%, EF-2 shall start on low speed. When the OA damper opens more than 80% EF-2 shall run on full speed. EF-1 and EF-2

shall alternate weekly for equal running time.

- E. Occupied Cooling (occupancy sensors provided by this contractor senses motion):
The supply fan shall continue to run and the dampers shall open to its minimum position listed in the schedule. On a call for cooling, the heating valve shall close, the circulating pump shall stop, the discharge sensor will first utilize the economizer for free cooling, as long as the supply air temperature is 2°F cooler than the space setpoint and the outside air enthalpy is less than 22 Btu/lb (adj.). When the economizer can no longer maintain space set-point, the DX cooling shall be enabled and the economizer dampers shall close to their minimum position. The economizer dampers open to their minimum positions and the unit discharge sensor shall maintain its setpoint by modulating the DX cooling.
- F. Demand ventilation control:
During the occupied mode, on a rise in return air CO₂ above 1000 PPM (adjustable), over a period of 10 minutes (adjustable) if after this period the CO₂ level has not dropped, then the economizer dampers shall continue to modulate open up to the maximum position listed in the schedule, subject to a mixed air limit sensor. After the indoor CO₂ concentration dropped below 600ppm (adjustable), the outside air damper shall return to its min position. This contractor shall provide outdoor CO₂ sensor. The CO₂ concentration shall be the difference between indoor and outdoor concentration. When the CO₂ concentration in the space exceeds 100ppm, an alarm shall be generated at the head-end.
- G. Unoccupied Heating:
The supply fans shall cycle on 100% return air and full heat to maintain the reduced unoccupied setpoint.
- H. Unoccupied Cooling:
The supply and return fans shall cycle on 100% return air. On a call for cooling, The heating valve shall close, the circulating pump shall stop, the discharge sensor will first utilize the economizer for free cooling, as long as the supply air temperature is 2°F cooler than the space setpoint and the outside air enthalpy is less than 22 Btu/lb (adj.). When the economizer can no longer maintain these conditions, the DX cooling shall be enabled and the economizer dampers shall close and the unit will run on 100% return air. The unit shall maintain space setpoint by modulating the cooling coil valve.

1.11 REFRIGERANT MONITORING

- A. Refrigerant leak detector installed in the mechanical room shall shut down the generate a visual and audible alarm at a remote location and at the head end. Horn and strobe light shall be provided by this contractor

Exhaust fan associated with the refrigerant monitoring system shall run all the time at half of its capacity. Upon detecting a refrigerant leak, the fan shall ramp up to deliver full air flow.

PART 2 - PRODUCTS

None

PART 3 - EXECUTION

3.1 INSTRUCTION AND ADJUSTMENTS

- A. Upon completion of the project, the Temperature Control Contractor shall: Check, validate, and calibrate, where required, all controllers, controlled devices, valves, actuators, auxiliary devices, relays, etc. provided under this section.

3.2 COORDINATION

- A. Coordinate the controls furnished under this section with the controls furnished with the boilers and chillers resulting in a complete system properly interfaced.

3.3 SYSTEM TURN OVER

- A. Upon completion of the installation, the Control Contractor shall start-up the system and perform all necessary testing and run diagnostics to ensure proper operation. An acceptance test in the presence of the Owner's Representative, the Architect, or the Engineer shall be performed. The acceptance test shall consist of a point-to-point check-out within each terminal unit controller to insure proper operation of all system components.
- B. When the system is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.
- C. Problems which occur within approved hardware or software shall be corrected in an appropriate fashion under warranty. Any such occurrence shall not void previous approval; however, the Control Contractor shall be responsible to attend to, and remedy, such items within the warranty period. Appropriate logs, schedules, and reports shall be maintained to reflect these items and their redress.

3.4 TRAINING/OWNER'S INSTRUCTION

- A. The Control Contractor shall provide two (2) copies of an operator's manual describing all operating and routine maintenance service procedures to be used with the system. The Control Contractor shall instruct the owner's designated representative in these procedures during the start-up and test period. The duration of the instruction is to be conducted during normal working hours and shall be no less than sixteen (16) hours.

3.5 WARRANTY

- A. The entire building control system shall be warranted for a period of (18) months following the date of beneficial use. Any manufacturing defects arising during this

period shall be corrected without cost to the owner. This warranty shall become effective starting the date the owner begins to receive beneficial use of the system.

END OF SECTION 230993

SECTION 239010 – BAS COMMISSIONING REQUIREMENTS

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. In addition to the drawings and general provisions of the contract, commissioning requirements are defined in the following sections:
 - 1. Section 019100 – General Commissioning Requirements
 - 2. Section 220800 – Plumbing Commissioning Requirements
 - 3. Section 230800 – HVAC Commissioning Requirements
 - 4. Section 260800 – Electrical Commissioning Requirements

1.2 SUMMARY

- A. This section includes commissioning process requirements for the Building Automation System (BAS) assemblies, equipment, software and programming.
- B. General commissioning requirements are described in Division 01 Section 019100 and are therefore not repeated in this Section.

1.3 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of the building automation and controls systems shall include verification of all systems operation that are controlled or monitored by the building automation system. BAS components include, but are not limited to:
 - 1. Control system hardware, wiring, sensors and actuators
 - 2. Operator stations and graphic displays
 - 3. System alarming and annunciation
 - 4. System operating control sequences
 - 5. Data trending and logging
 - 6. User access and password protection
 - 7. Remote system access
 - 8. Door access
 - 9. Control hardware

1.4 SUBMITTALS

- A. Refer to Division 01 Section 013300 “Submittal Procedures” for specific requirements.
- B. In addition, provide the following:

1. Certificates of readiness
 2. Certificates of completion of installation, prestart, and startup activities.
 3. Contractor and equipment vendor startup and test reports
- C. Control Drawings Submittals
1. The control drawings shall have a key to all abbreviations.
 2. The control drawings shall contain graphic depictions of the systems and each component.
 3. The diagrams shall include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 4. Provide a full points list with at least the following included for each point:
 - a. Controlled system
 - b. Point abbreviation
 - c. Point description
 - d. Display unit

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall furnish all standard testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested.
- B. For example, the Mechanical Contractor shall furnish all standard testing equipment for the BAS system and controls system in Division 23, except for equipment specific to and used by TAB in their commissioning responsibilities. A sufficient quantity of two-way radios shall be provided by each subcontractor.
- C. Refer to Division 01 Section 019100 "Commissioning" for a detailed description of test equipment requirements.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. The Controls Contractor shall document all BAS testing and startup activities using his own forms. Completed test and startup forms shall be submitted to the CxA for review.
- B. Record Documents
 1. Red-lined and As-Built Drawings The contractor shall verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.

2. The Controls Contractor shall furnish the Commissioning Team with preliminary red-lined drawings for use prior to the start of Functional Performance Testing.
3. Changes resulting from Functional Testing shall be incorporated into the final as-built drawings to be created from the red-lined drawings.
4. The contracted party, as defined in the Contract Documents, shall create the as-built drawings.
5. All red-lined drawings shall to be available on-site for review by the Owner and the CxA.

C. Operation and Maintenance Data

1. Contractor shall provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
2. The CxA will review the O&M literature once for conformance to project requirements.
3. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.

D. Demonstration and Training

1. The contractor shall contribute to and review training documentation in O&M Manuals.

E. Systems Manual Requirements

1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
2. The GC shall include final approved versions of the following information for the Systems Manual:
 - a. As-Built System Diagrams
 - b. Verified Record Drawings
 - c. Test Results (not otherwise included in Cx Record)
 - d. Periodic Maintenance Information for computer maintenance management system
 - e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - g. Training Records, Information on training provided, attendees list, and any on-going training
3. This information shall be organized and arranged by building system, such as fire alarm, chilled water, heating hot water, etc.
4. Information should be provided in an electronic version to the extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

3.2 COMMISSIONING TEAM RESPONSIBILITIES

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for commissioning team member roles and responsibilities.

3.3 TESTING PREPARATION

- A. Certify in writing to the CxA that BAS systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.
- B. Certify in writing to the CxA that BAS instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- C. Certify in writing that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.
- D. Place systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).
- E. Inspect and verify the position of each device and interlock identified on checklists.
- F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- G. If the failure rate of a similar family of equipment or devices is greater than 10%, then the Owner shall be notified. The matter shall be addressed by the Owner, GC, CxA, and other applicable parties. The failure issue shall be resolved to the Owner’s satisfaction.

3.4 TESTING, ADJUSTING AND BALANCING VERIFICATION

- A. Provide technicians, instrumentation, and tools to verify testing and balancing of BAS systems at the direction of the TAB Contractor.

3.5 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of BAS testing shall include entire BAS installation, including control system hardware, wiring, sensors, operator terminals, software programming, graphic displays, alarms and data storage. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of BAS controllers and sensors.

- C. The CxA along with the BAS contractor, testing and balancing Subcontractor, and BAS Instrumentation and Control Subcontractor shall prepare detailed testing plans, procedures, and checklists for BAS systems, subsystems, and equipment.
- D. Tests shall be performed using design conditions whenever possible.
- E. Testing may require imposition of simulated conditions of artificial loads when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.
- F. The CxA may direct that set points be altered when simulating conditions is not practical.
- G. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- H. If tests cannot be completed because of a deficiency outside the scope of the BAS system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- I. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.6 RETESTING, FAILURE DUE TO PRODUCT DEFECTS

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to deficiencies, non-conforming conditions, cost of retesting, and failures due to product defects.

3.7 APPROVALS

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for approval procedures.

3.8 DEFERRED TESTING

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.9 OPERATION AND MAINTENANCE MANUALS

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to operation & maintenance manuals.

3.10 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to training of owner personnel.
- B. The Controls Contractor shall provide designated Owner personnel with comprehensive orientation and training in the understanding, operation and maintenance of the control and building automation systems, and include procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment. Training is intended to instruct the Owner on all the capabilities of the control system clearly and completely.
 1. Provide the CxA and AE with a training plan four (4) weeks before the planned training.
 2. The contractor shall submit a training agenda one (1) week prior to each session for review by the CxA.
 3. Training manuals. The standard operating manual for the system and any special training manuals shall be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual shall be demonstrated during training and three copies submitted with the O&M manuals.
 4. Manuals shall include detailed description of the subject matter for each session. Manuals shall cover all control sequences and have a definitions section that fully describes all relevant words and abbreviations used in the manuals and in all software displays. The CxA and the AE will review and approve all manuals. Copies of audiovisuals shall be delivered to the Owner.
 5. Training sessions shall be tailored to the needs and skill levels of the trainees. Trainers shall be knowledgeable on the system and its use in buildings. The contractor shall employ the most qualified trainers for the on-site sessions. The Owner will approve trainers prior to scheduling the training.
 6. Should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations during any demonstration, the system shall be repaired or adjusted as necessary and the demonstration repeated.
 7. The controls contractor shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 8. All training sessions with the Owner’s personnel shall be professionally digitally video recorded by trade (mechanical, electrical plumbing) and a DVD provided with the O&M manuals.
 9. Training shall be conducted in (3) phases:
 - a. Training Phase I. – Basic Control System Operation. The first training shall consist of general system user training. This training may be held on-site or in the supplier’s facility. If held off-site, the training may occur prior to final completion of the system installation. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations and describe general hardware architecture and functionality of

the system. If owner personnel are sufficiently competent, the Owner may choose to waive this training phase.

- b. Training Phase II. - Building Control Systems Operation. The second session shall be held on-site for actual hands-on training after the completion of system commissioning. The session shall include instruction on:
- 1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.
 - 2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing set points and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed shall adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
 - 3) All trending and monitoring features, such as values, change of state, and totalization. Instruction in trending shall include setting up, executing, downloading, viewing both tabular and graphically and printing trends. The Contractor shall require trainees to set-up actual trends in the presence of the trainer.
 - 4) Every screen shall be completely discussed, allowing time for questions.
 - 5) Use of keypad or plug-in laptop computer at the zone level.
 - 6) Use of remote access to the system via phone lines or networks.
 - 7) Setting up and changing an air terminal unit controller.
 - 8) Graphics generation
 - 9) Point database entry and modifications
 - 10) Understanding DDC field panel operating programming (when applicable)
- c. Training Phase III. – Building Systems Follow-Up Training. The third training shall be conducted on-site six months after occupancy. The session shall be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system.

END OF SECTION 239010

SECTION 260800 – ELECTRICAL COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplemental General Conditions and other Division 01 Specification Sections, apply to this section.
- B. In addition to the drawings and general provisions of the contract, commissioning requirements are defined in the following sections:
 - 1. Section 019100 – General Commissioning Requirements
 - 2. Section 220800 – Plumbing Systems Commissioning Requirements
 - 3. Section 230800 – HVAC Systems Commissioning Requirements
 - 4. Section 230910 – Building Automation System Commissioning Requirements

1.2 SUMMARY

- A. This section includes commissioning process requirements for Electrical systems, assemblies, and equipment.
- B. General commissioning requirements are described in Division 01 Section 019100 and are therefore not repeated in this Section.

1.3 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of the electrical systems shall include, but are not limited to:
 - 1. Normal power distribution systems, including new service switchgear, switchboards, panelboards, and convenience outlets.
 - 2. New emergency power distribution system, including new emergency generator, new automatic transfer switches, and annunciators.
 - 3. Variable frequency controllers and across-the-line starters at new mechanical and plumbing equipment.
 - 4. Normal and emergency lighting fixtures and control systems.
 - 5. Fire alarm systems.
 - 6. Grounding and lightning protection systems.
 - 7. Life safety systems.

1.4 SUBMITTALS

- A. Refer to Division 01 Section 013330 “Submittal Procedures” for specific requirements.
- B. In addition, provide the following:
 - 1. Certificates of readiness
 - 2. Certificates of completion of installation, prestart, and startup activities.

3. O&M manuals
4. Test reports
5. Completed Construction Checklists

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall furnish all standard testing equipment required to perform startup, initial checkout and functional performance testing for the equipment being tested. For example, the electrical contractor of Division 26 shall ultimately be responsible for all standard testing equipment for the electrical systems and controls systems in Division 26. A sufficient quantity of two-way radios shall be provided by each contractor.
- B. Refer to Division 01 Section 019100 "General Commissioning Requirements" for a detailed description of test equipment requirements.

PART 3 - EXECUTION

3.1 GENERAL DOCUMENTATION REQUIREMENTS

- A. With assistance from the installing contractors, the CxA will prepare Construction Checklists for all commissioned components, equipment, and systems.
- B. Red-lined and As-Built Drawings
 1. The contractor shall verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.
 2. Preliminary red-lined drawings shall be available to the Commissioning Team for use prior to the start of Functional Performance Testing.
 3. The Contractor shall incorporate changes resulting from Functional Testing into the final as-built drawings to be created from the red-lined drawings.
 4. The contracted party, as defined in the Contract Documents, shall create the As-Built drawings.
 5. All red-lined drawings shall be available on-site for review by the Owner and the CxA.
- C. Operation and Maintenance Data
 1. Contractor shall provide a copy of O&M literature within (45) days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.
 2. The CxA will review the O&M literature once for conformance to project requirements.
 3. The CxA shall receive a copy of the final approved O&M literature after the contractor has completed corrections.
- D. Demonstration and Training

1. Contractor shall provide demonstration and training as required by the specifications.
2. A complete training plan and schedule shall be submitted by the Contractor to the CxA four weeks (4) prior to any training.
3. A training agenda for each training session shall be submitted to the CxA one (1) week prior to training.
4. Engage a Factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specific equipment.
5. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, trouble shooting, servicing, and maintaining equipment.
6. Review data in O&M Manuals.

E. Systems Manual Requirements:

1. The Systems Manual is intended to be a usable information resource containing all of the information related to the systems, assemblies, and Commissioning Process in one place with indexes and cross references.
2. The GC shall include final approved versions of the following information for the Systems Manual:
 - a. As-Built System Diagrams
 - b. Verified Record Drawings
 - c. Test Results not otherwise included in Cx Record
 - d. Periodic Maintenance Information for computer maintenance management system
 - e. Recommendations for recalibration frequency of sensors and actuators
 - f. A list of contractors, subcontractors, suppliers, architects, and engineers involved in the project along with their contact information
 - g. Training Records, Information on training provided, attendees list, and any on-going training
3. This information shall be organized and arranged by building system, such as fire alarm, chilled water, heating hot water, etc.
4. Information should be provided in an electronic version to the greatest extent possible. Legible, scanned images are acceptable for non-electronic documentation to facilitate this deliverable.

3.2 COMMISSIONING TEAM RESPONSIBILITIES

- A. Refer to Division 01 Section 019100 "General Commissioning Requirements" for commissioning team member roles and responsibilities.

3.3 TESTING PREPARATION

- A. The CxA shall be notified at least (72) hours in advance of scheduled tests so that testing may be observed by the CxA and Owner's representative. A copy of the test record shall be provided to the CxA, Owner, and Architect.
- B. Certify in writing to the CxA that Electrical systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

- C. Certify in writing to the CxA that Electrical instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.
- D. Certify in writing that testing procedures have been completed and that testing reports have been submitted, discrepancies corrected, and corrective work approved.
- E. Place systems, subsystems, and equipment into operating modes to be tested, including normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions, as specified and as directed.
- F. Inspect and verify the position of each device and interlock identified on checklists.
- G. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.
- H. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.
- I. If the failure rate of a similar family of equipment or devices is greater than 10%, the contractor shall notify the Owner. The matter shall be addressed by the Owner, GC, CxA, and other applicable parties. The failure issue shall be resolved to the Owner's satisfaction.

3.4 GENERAL TESTING REQUIREMENTS

- A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.
- B. Scope of Electrical testing shall include the entire Electrical installation, from the incoming power equipment throughout the distribution system. Testing shall include measuring, but not limited to resistance, voltage, and amperage of systems and devices.
- C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.
- D. The CxA along with the Electrical contractor and other contracted subcontractors, including the fire alarm Subcontractor shall prepare detailed testing plans, procedures, and checklists for Electrical systems, subsystems, and equipment.
- E. Tests shall be performed using design conditions whenever possible.
- F. Artificial loads may be required to simulate conditions when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

- G. The CxA may direct that set points be altered when simulating conditions is not practical.
- H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.
- I. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.
- J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.5 TESTING PROCEDURES

- A. Equipment Testing and Acceptance requirements are specified in individual Division 26 sections. Provide submittals, test data, inspector record, infrared camera and certifications to the CA.
- B. Provide technicians, load banks, infrared cameras, instrumentation, tools and equipment to test performance of designated normal and emergency generator and power systems and devices at the direction of the CxA.

3.6 DEFICIENCIES

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to deficiencies, non-conforming conditions, costs of retesting, or failures due to product defects.

3.7 APPROVAL

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for approval procedures.

3.8 DEFERRED TESTING

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to deferred testing.

3.9 OPERATION AND MAINTENANCE MANUALS

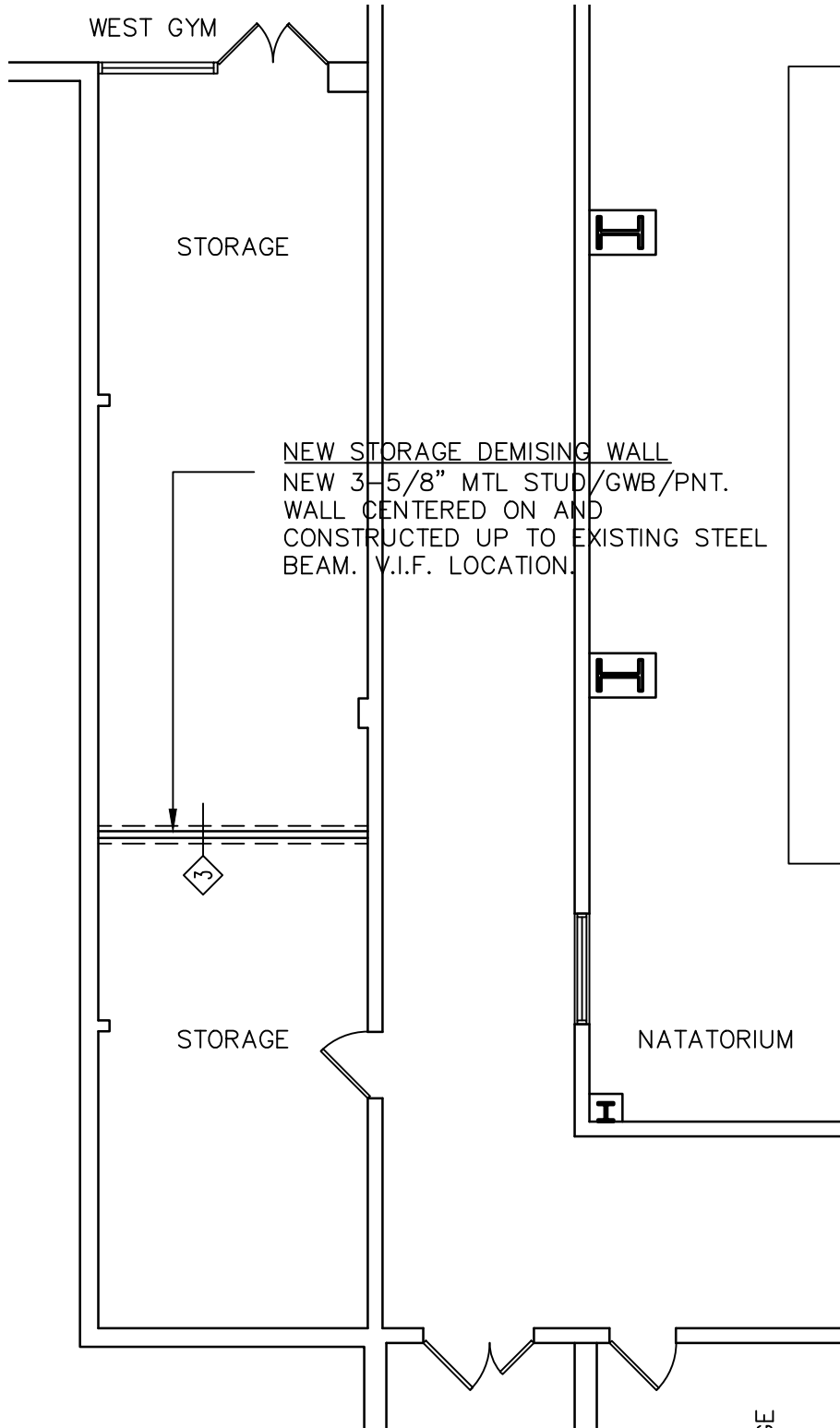
- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to operation and maintenance manuals.

3.10 TRAINING OF OWNER PERSONNEL

- A. Refer to Division 01 Section 019100 “General Commissioning Requirements” for requirements pertaining to training.
- B. The electrical contractor shall have the following training responsibilities:

1. Provide the CA with a training plan four (4) weeks before the planned training.
2. Provide designated Owner personnel with comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of commissioned electrical equipment or system.
3. Training shall start with classroom sessions, if necessary, followed by hands on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system shall be repaired or adjusted as necessary and the demonstration repeated.
5. The Contractor shall provide one or more qualified instructors as appropriate to the equipment or systems. The instructor may be the start-up technician for the piece of equipment, the installing contractor or manufacturer's representative. The instructor shall possess practical expertise and in-depth knowledge of all modes of operation for each specific piece of equipment.
6. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
7. Training shall include:
 - a. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Include a review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discuss relevant health and safety issues and concerns.
 - d. Discuss warranties and guarantees.
 - e. Cover common troubleshooting problems and solutions.
 - f. Explain information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discuss any peculiarities of equipment installation or operation.
8. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance of all pieces of equipment.
9. The electrical contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
10. All training sessions with the Owner's personnel shall be professionally digitally video recorded by trade (mechanical, electrical plumbing) and provided with the O&M manuals.
11. Training shall occur after functional testing is complete, unless approved otherwise by the Owner.

END OF SECTION 260800



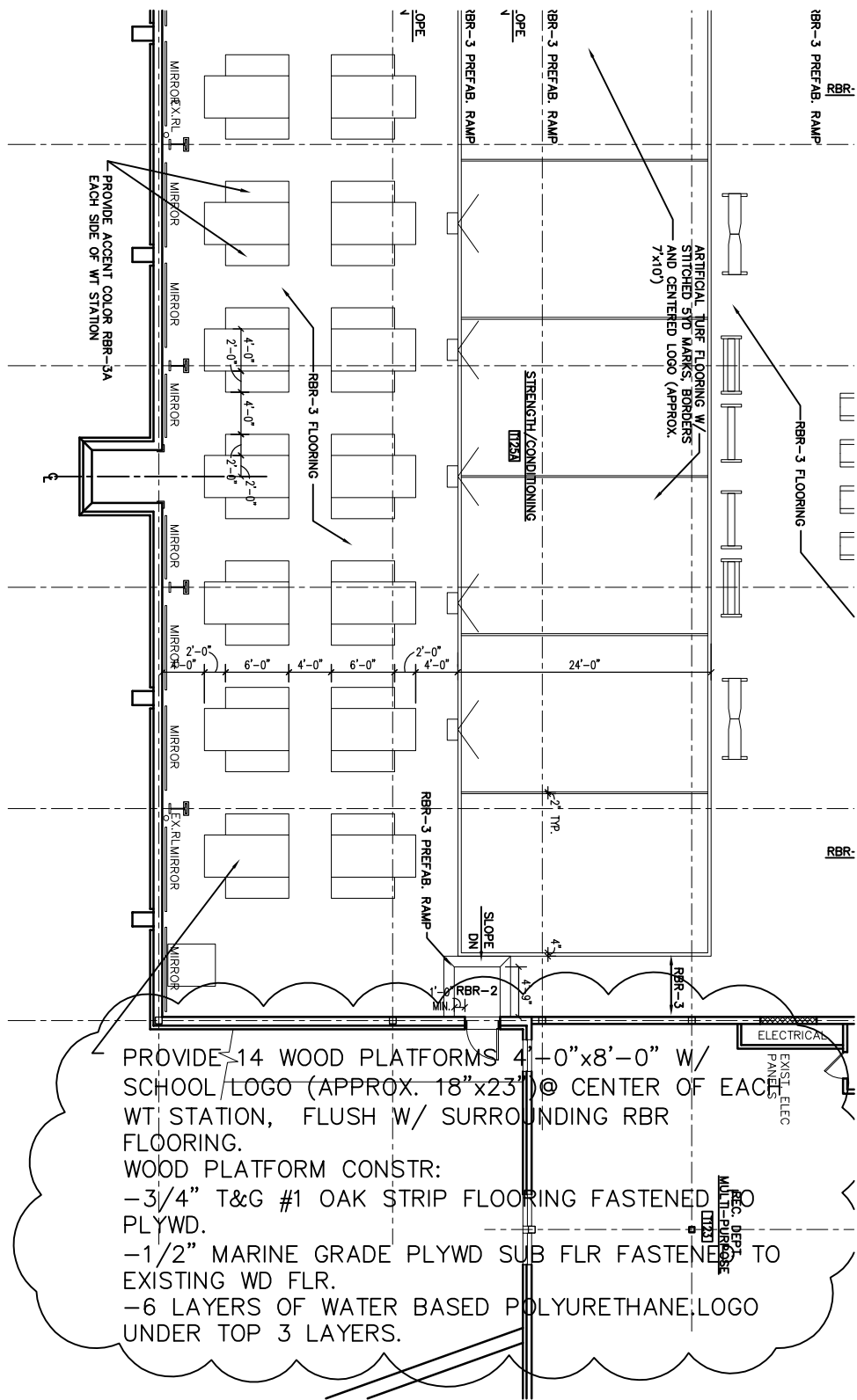
PROJECT
NORTH



**moser
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architects**
30 JORDAN LANE
WETHERSFIELD, CT. 06109
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PROJECT TITLE
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STUDENT ATHLETE DEVELOPMENT CENTER
SKETCH TITLE
DEMISING WALL

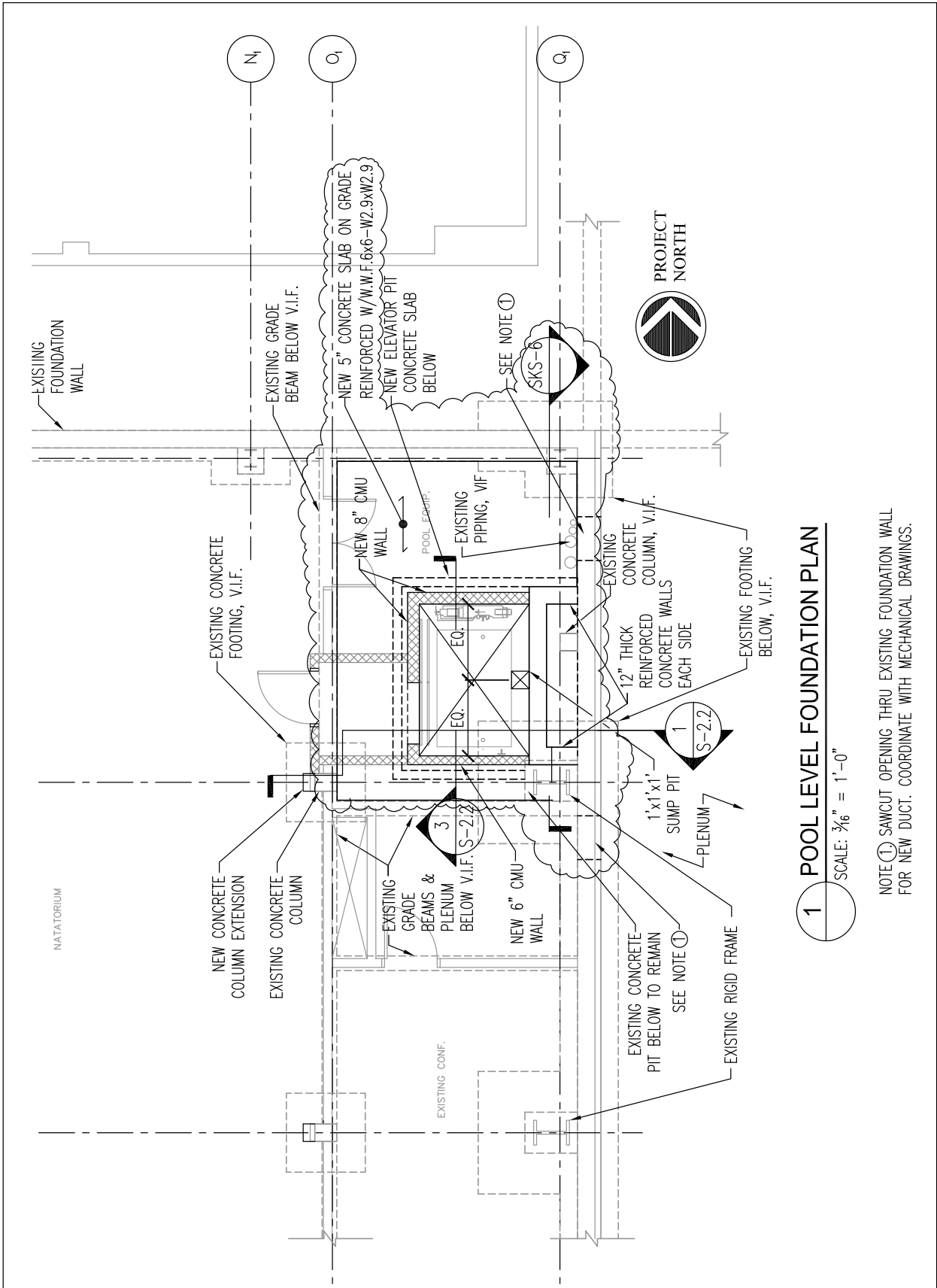
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AD3 SK-1-A11



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 pilon
 nelson
 architects**
 30 JORDAN LANE
 WETHERSFIELD, CT. 06109
 860 563 6164

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1 POOL LEVEL FOUNDATION PLAN

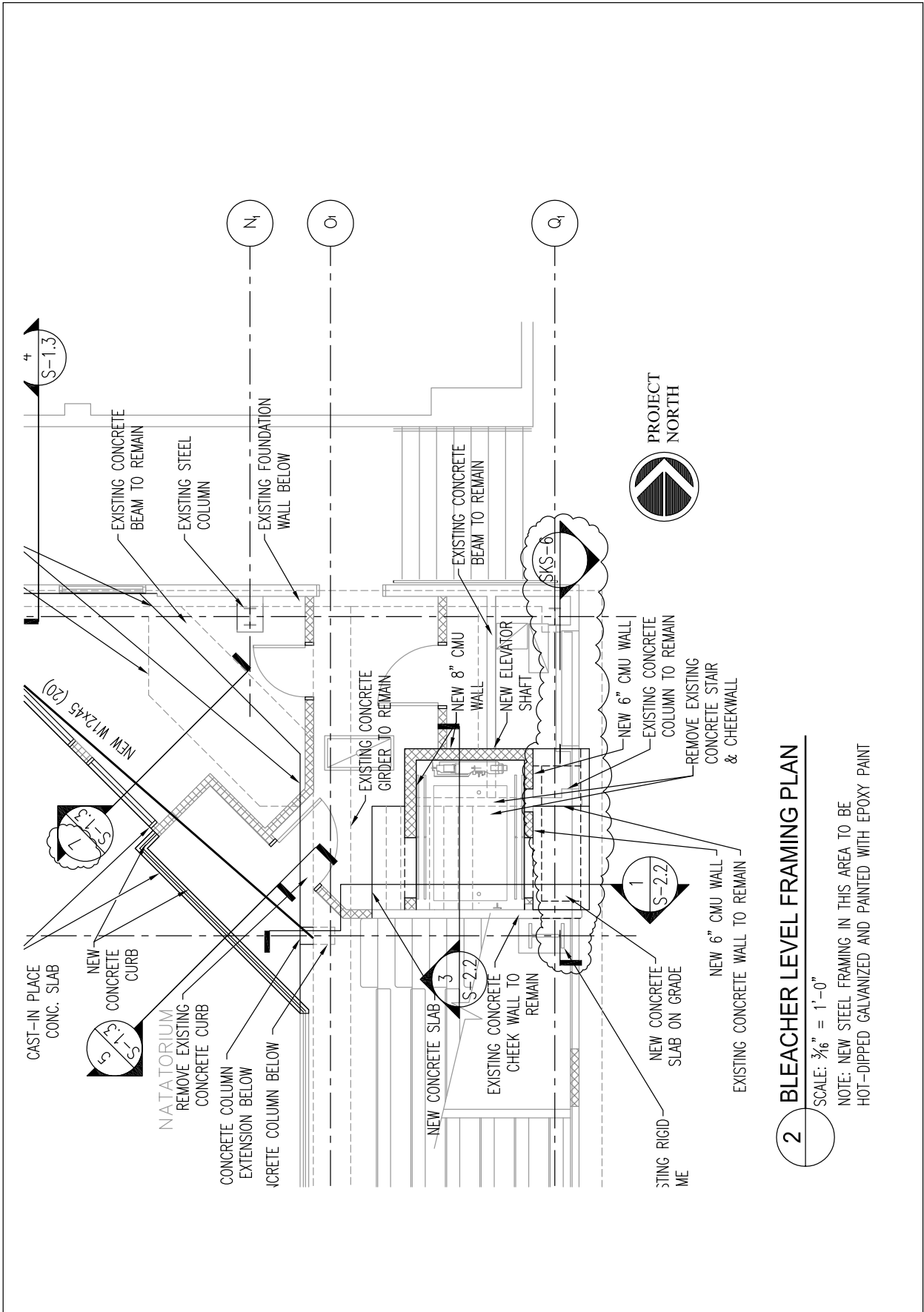
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NOTE ① SAWCUT OPENING THRU EXISTING FOUNDATION WALL FOR NEW DUCT. COORDINATE WITH MECHANICAL DRAWINGS.

GM2 ASSOCIATES
 115 GLASTONBURY BLVD.
 GLASTONBURY, CT.
 860 659 1416

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	REVISED PARTIAL POOL FOUNDATION PLAN

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2 BLEACHER LEVEL FRAMING PLAN

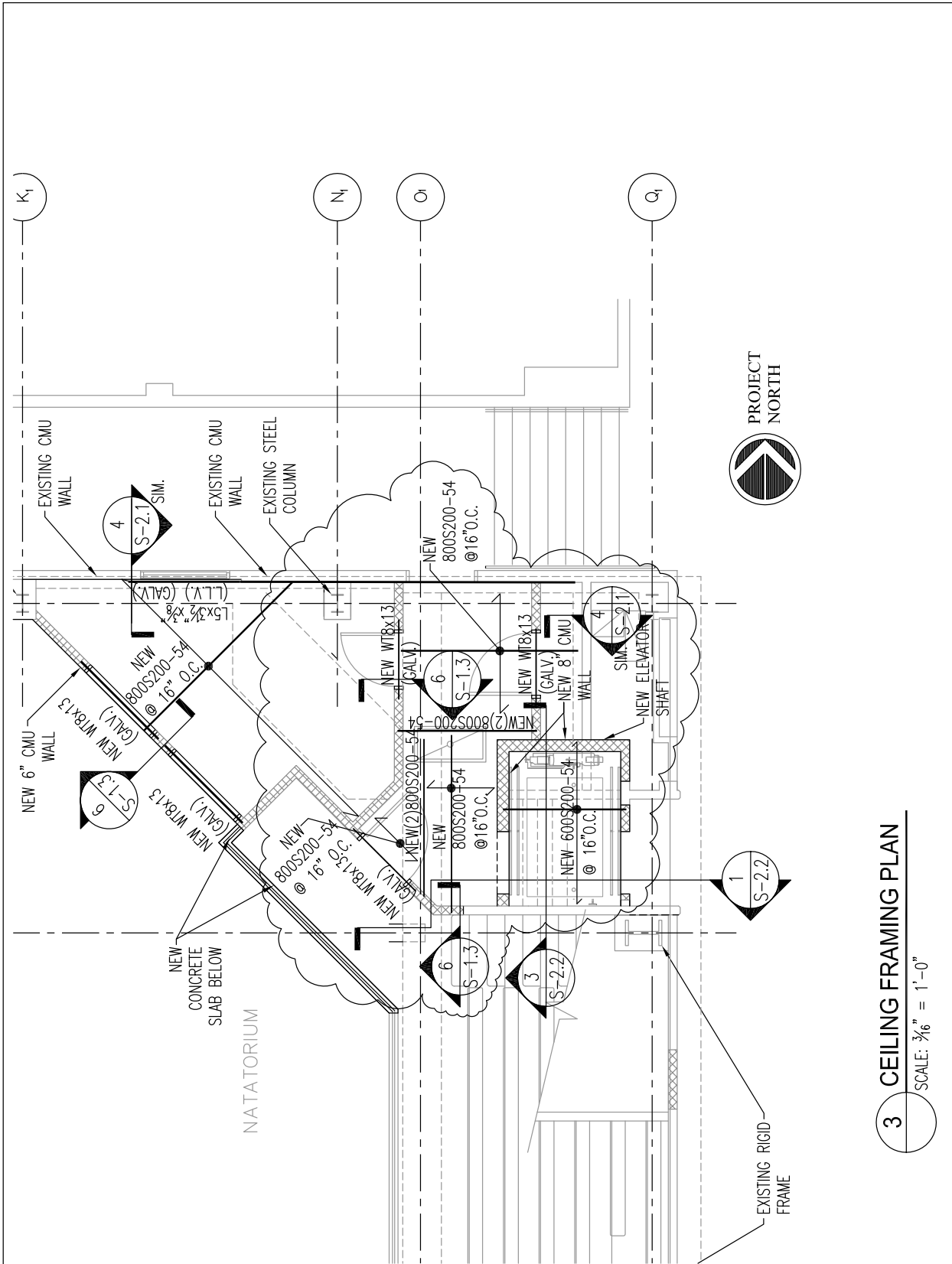
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NOTE: NEW STEEL FRAMING IN THIS AREA TO BE HOT-DIPPED GALVANIZED AND PAINTED WITH EPOXY PAINT

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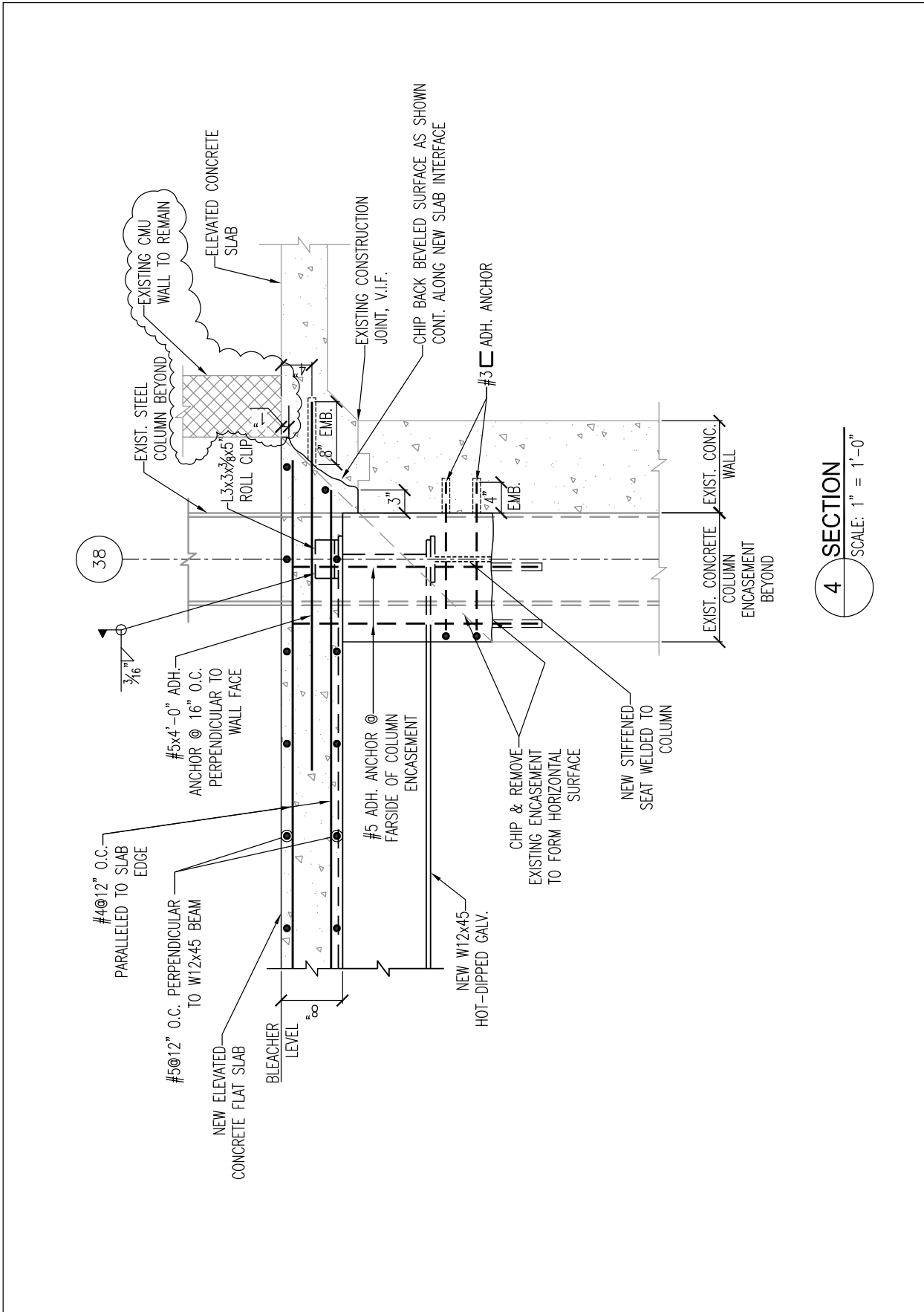


3 CEILING FRAMING PLAN
 SCALE: 3/16" = 1'-0"

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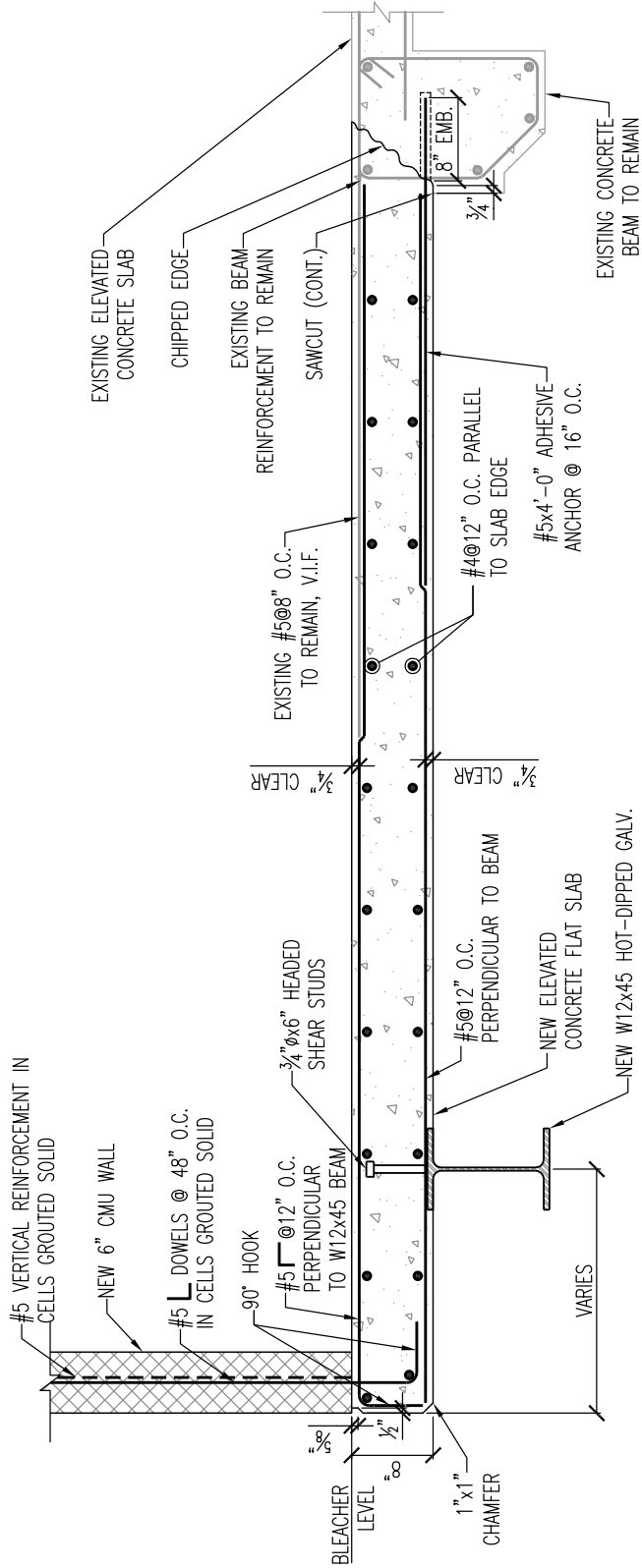


4 SECTION
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GLASTONBURY, CT.
860 659 1416

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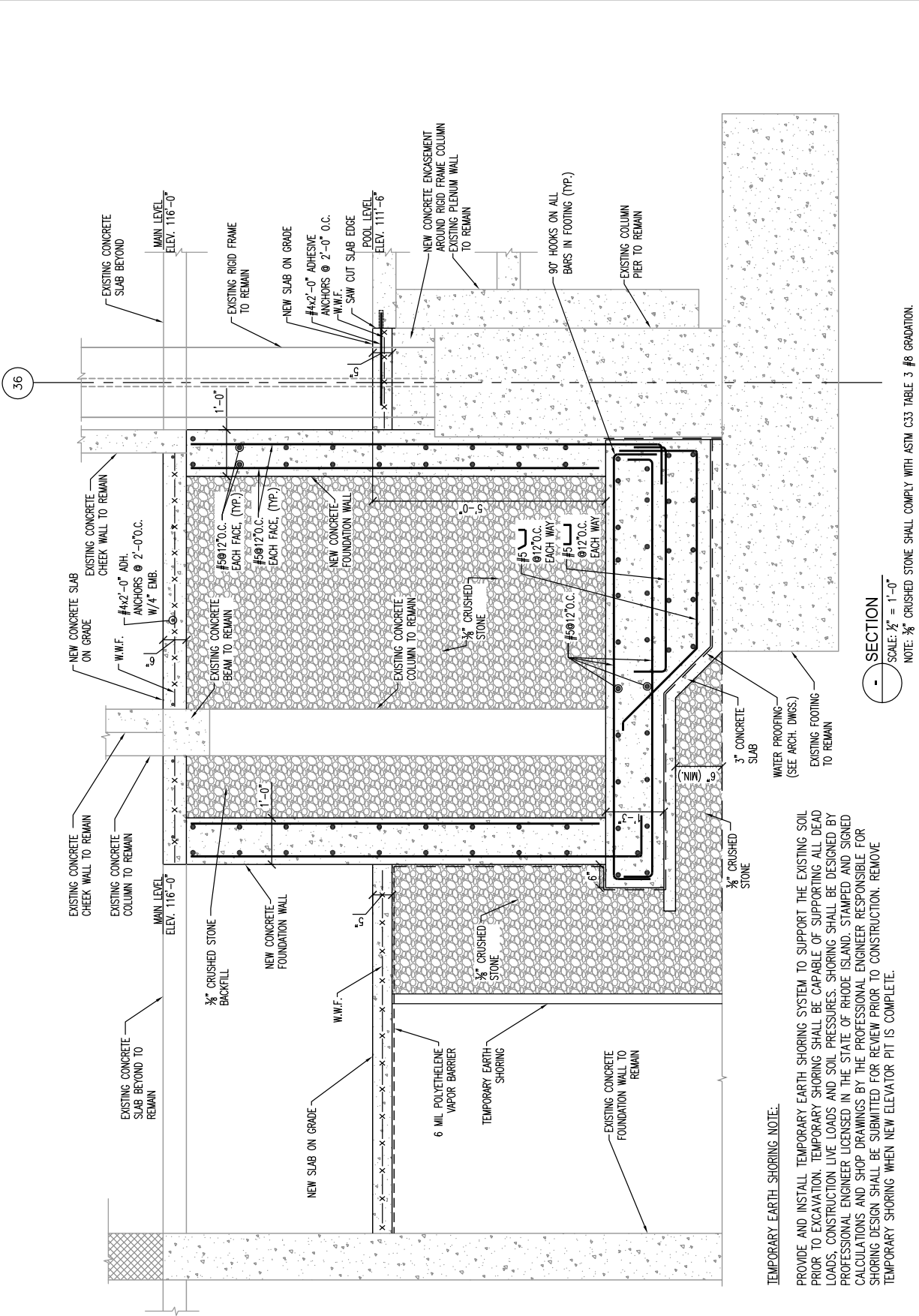


7 SECTION
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GLASTONBURY, CT.
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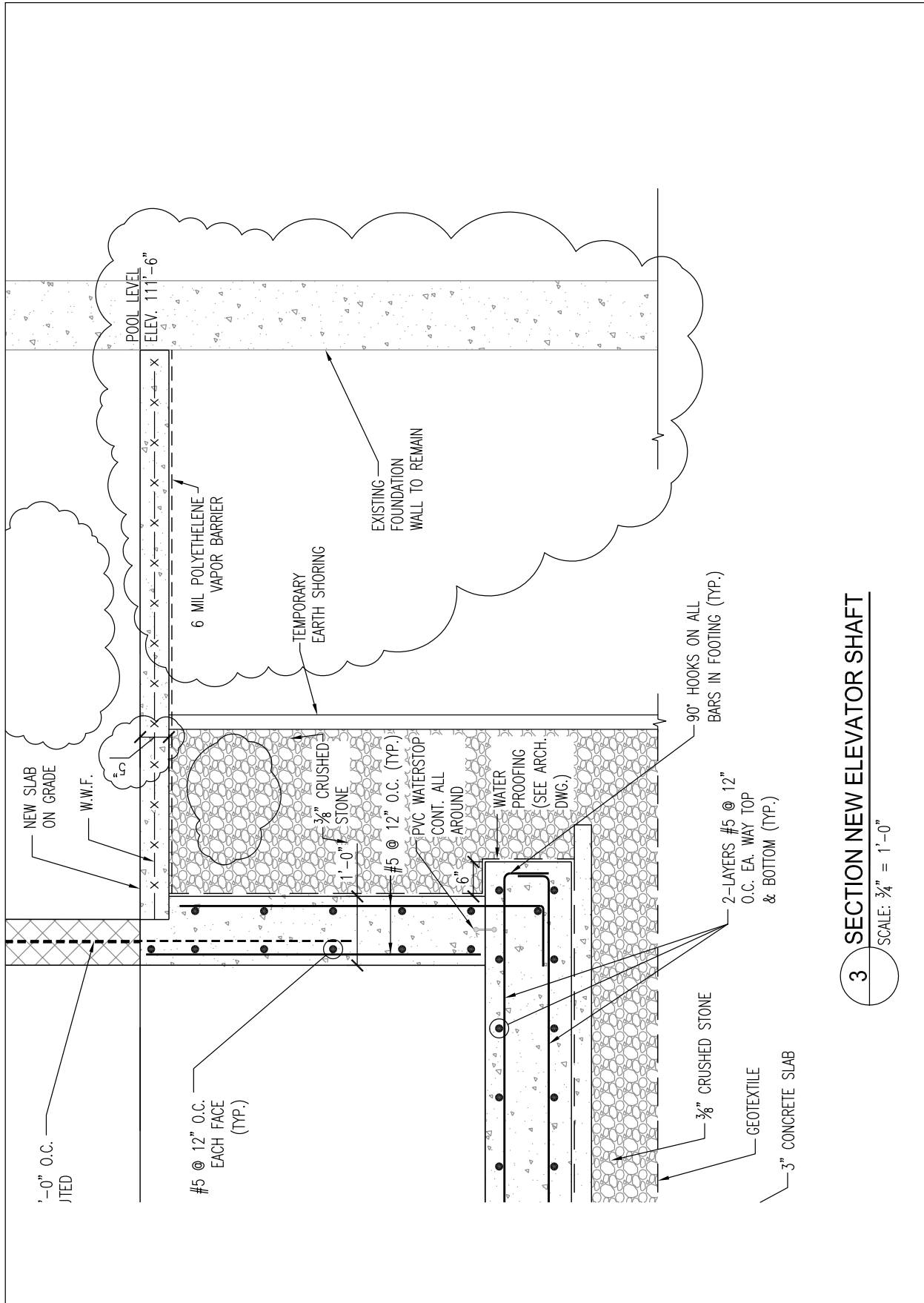
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STUDENT ATHLETE DEVELOPMENT CENTER
 SKETCH TITLE NEW SECTION AT ELEVATOR PIT

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 SKETCH NO. AD1 SK-S-6

TEMPORARY EARTH SHORING NOTE:
 PROVIDE AND INSTALL TEMPORARY EARTH SHORING SYSTEM TO SUPPORT THE EXISTING SOIL PRIOR TO EXCAVATION. TEMPORARY SHORING SHALL BE CAPABLE OF SUPPORTING ALL DEAD LOADS, CONSTRUCTION LIVE LOADS AND SOIL PRESSURES. SHORING SHALL BE DESIGNED BY PROFESSIONAL ENGINEER LICENSED IN THE STATE OF RHODE ISLAND. STAMPED AND SIGNED CALCULATIONS AND SHOP DRAWINGS BY THE PROFESSIONAL ENGINEER RESPONSIBLE FOR SHORING DESIGN SHALL BE SUBMITTED FOR REVIEW PRIOR TO CONSTRUCTION. REMOVE TEMPORARY SHORING WHEN NEW ELEVATOR PIT IS COMPLETE.

SECTION
 SCALE: 1/2" = 1'-0"

NOTE: 3/4" CRUSHED STONE SHALL COMPLY WITH ASTM C33 TABLE 3 #8 GRADATION.



3 SECTION NEW ELEVATOR SHAFT

SCALE: 3/4" = 1'-0"

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860 659 1416

PROJECT TITLE

UNIVERSITY OF RHODE ISLAND

STUDENT ATHLETE DEVELOPMENT CENTER

SKETCH TITLE

REVISED PARTIAL SECTION 3/S-2.2

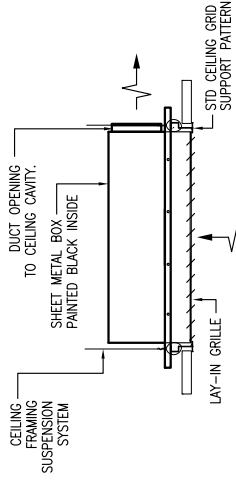
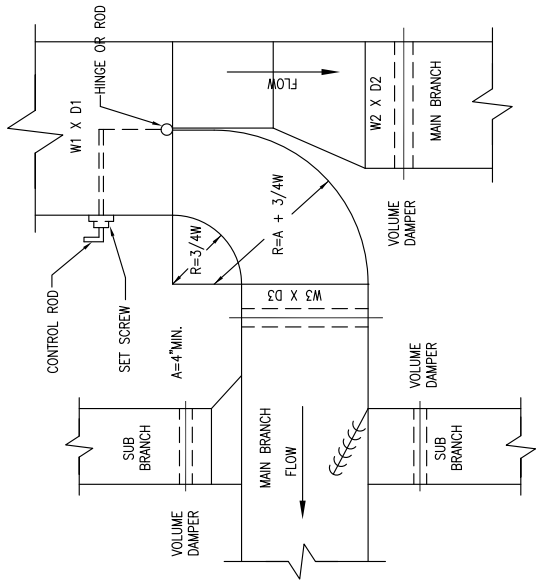
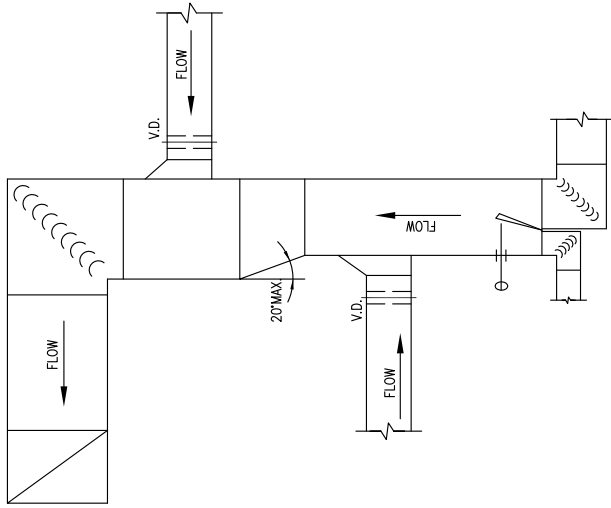
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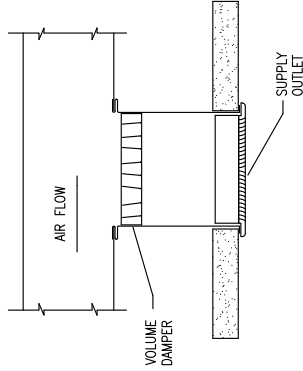
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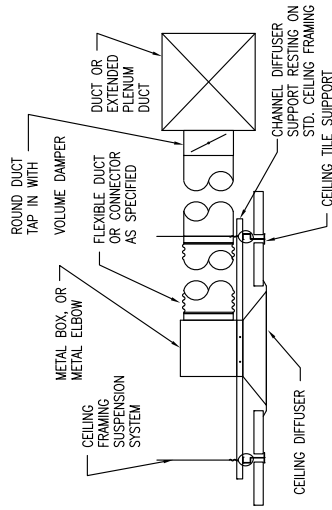
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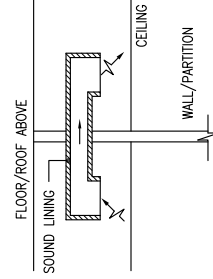
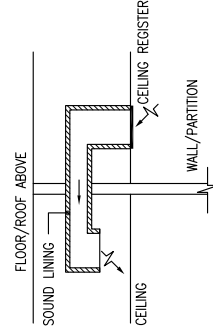
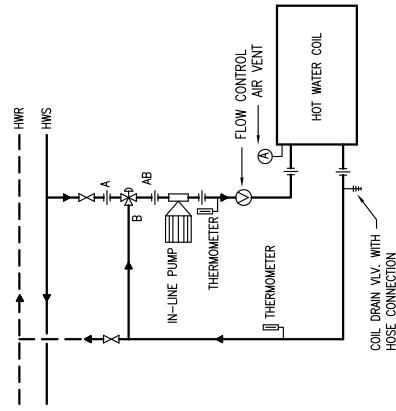
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NO SCALE



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REGISTER CONNECTION
NO SCALE



CEILING DIFFUSER BRANCH DUCT
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TRANSFER DUCT TYPICAL DETAIL
NO SCALE

TRANSFER DUCT TYPICAL DETAIL
NO SCALE



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SKETCH TITLE MECHANICAL DETAILS

SCALE: NONE
SKETCH NO. AD3 SK-M1

AHU HOT WATER COIL PIPING DIAGRAM
NO SCALE