

## Addendum #2

Date: August 31, 2018  
Project: Carvel State Office Building -  
Lobby Renovations

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The work herein shall be considered part of the bid documents for the referenced project and carried out in accordance with the following supplemental instructions issued in accordance with the Contract Documents without change in Contract Sum or Contract Time. Acknowledge receipt of addendum on the bid form as indicated.

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### Changes to the Drawings

1. E9.0 – Added “or approved equal” to the manufacturer/catalog number of light fixture types H and L in the light fixture schedule. Removed fixture types C and F, and added fixture types C1, C2, and C3.
2. E9.1 – Added a general demolition note. Added demolition of radiator units. Added demolition of door opener buttons and motors. Revised the demolition of the overhead grille controls in the elevator lobby.
3. E9.2 – Added temporary suspension of corridor light fixtures.
4. E9.3 – Revised name of panel in 2 ½ floor east storage room.
5. E9.4 – Added a general demolition note. Added demolition of radiator units. Revised the demolition of the overhead grille controls in the elevator lobby.
6. E9.5 – Revised art room light switch demolition work.
7. E9.6 – Relocated the elevator emergency phone. Revised new overhead grille controller note. Added pathway of conduits for panel-DPL-G1 and 150KVA xfmr.
8. E9.7 – Revised the location of light switches a, b, c, d, e, f, g, & h. Added switch 3p. Revised fixture type designations.
9. E9.8 – Revised name of panel in 2 ½ floor east storage room.
10. E9.9 – Revised new overhead grille controller note. Added new receptacles.
11. E9.10 – Revised fixture type designations. Revised art room switches. Revised lighting in the dunkin donuts.
12. E9.11 – Added a circuit breaker to panel-DPL-G1. Revised single line diagram.
13. E9.12 – added new sheet E9.12 with a fourth floor plan.
14. A2.1, A2.2
  - a. Clarified keynotes D-30, D-32, D-33, D-38.
  - b. Added new keynotes D-42 through D-45
  - c. Correctly identify walls to demo (D-43)
  - d. Clarify demo of walls, door, and equip. in existing Open Office 103.
  - e. Detailed scope in Elevator Lobbies for painting, signage.
  - f. General notes added.
  - g. Partial demo of column base and trim.
  - h. Add removable panel for access under stairs.
15. A2.3, A2.4
  - a. Add scope of ceiling work to facilitate ductwork install in corridor
  - b. Reinstall track lighting in arts council display
  - c. Remove wall covering in soffit for painting.

16. A3.1, A3.2
  - a. Added wall types
  - b. Located FEC and new signage locations.
  - c. Updated column/wall detail by Vestibule 000A
  - d. Install controls for rolling gate in existing box
  - e. New chase in Facilities Mgmt Rcpt 245 for baseboard.
  - f. Keynote C-40
17. A3.3, A3.4
  - a. Install new grid and tile where ductwork was installed in corridor
  - b. New soffit at Dunkin Donuts
18. A3.5 –
  - a. New sheet, enlarged unisex toilet 103A, elevations, toilet accessories, mounting heights
  - b. Wall detail at column by Vestibule 000A
  - c. Fire command center enlarged plan, handrail details, railing details
19. A3.6 –
  - a. Clarify NIC and in scope work
  - b. Updated soffit details
20. A4.3 – Correct plan of east ramp, removed details that not apply, update detail at cast-in-place steps.
21. A4.4 – Correct handrail and guardrail to stainless steel, clarify wood panel on gypsum board
22. A7.1, A7.2 – Typical column paint colors, update finish legend, carpet extended to capitol police steps, paint door and frame, trim and base.
23. A7.3 – Solid surface countertop on capitol police casework
24. A7.4 – Clarify 4'x8' FRP panel and plywood assembly, solid surface countertop

#### **Changes to the Specifications**

1. 01 79 00 – Replace section in its entirety.
2. Added Section 03 35 33 Stamped Concrete
3. 08 33 00 – Rolling Grilles – Grilles to be motorized
4. 09 68 00 – Carpeting – There will NOT be any accent carpet tiles.
5. Added Section 09 77 16 Framed Decorative Panel System
6. 09 96 00 – Textured Acrylic Coating for Interior Wall Finishes – Texture to be Tight Knockdown Fissure
7. Added Section 10 28 13 – Toilet Accessories
8. 23 05 93 - Replace section in its entirety.
9. 23 07 19 - Replace section in its entirety.
10. 23 09 50 - Replace section in its entirety.
11. 23 31 00 - Replace section in its entirety.
12. 23 36 00 - Replace section in its entirety.
13. 23 52 16 - Replace section in its entirety.
14. 23 74 10 - Replace section in its entirety.

### Clarifications

1. Lift Pump Station basis of design shall be Bell & Gossett Sewage Lift Pump, Model 1EC0512, .50hp – 1/60/230v, 4.7a, 1 1/2" Discharge. Provide 24" x 84" Basin.
2. All new glass railing details at steps and ramps on A4.5 shall follow Section 057310 Dry Glazed Glass Railing System. See Clarification #3
3. All handrails, posts, brackets, balustrades, bases, caps, and guardrails to be stainless steel grade 304. Only the assembly within the Fire Command Center is to be painted steel.
4. All new terrazzo is to match existing in terms of color, aggregate type and aggregate size. A mock up area of 2'x2' will be required for review and approval.
5. All gypsum wall board to be impact resistant unless located in restroom.
6. Door hardware allowance provided for material only. Installation of door hardware on all new doors is to be included in base bid.
7. Graphic FRP allowance provided for material only. Installation of FRP panel over fire treated plywood is to be included in base bid.
8. All plywood used construction is to be fire treated.
9. Contractor to provide quantity (12) 6"x6" terrazzo patches. Location to be determined in the field but the architect.
10. Contractor to finish edge of steps in lobby with terrazzo.
11. Contractor to install rubber tread and risers in steps in Fire Command Center.

### RFI's

1. Do you know if the concrete slabs in the Carvel Building have post tensioned strands that we will need to locate for core drilling?  
**We do not, however contractor is to own ground penetrating radar to scan the slab prior to any core drilling.**
2. We could use more information on the toilet accessories required for this alternate.  
**See attached drawing A3.5 and specifications/schedule**
3. The Glazing spec calls for 3M S800 on page 4 and the window film spec on page 3 calls for S600. Please clarify.  
**Use 3M S800.**
4. Pre Bid Minutes Agenda Note #13 states Wayman Fire Protection is the state vendor from the building. Are we permitted to use other sprinkler contractors for the work?  
**Wayman is not state vendor, so other contractors are permitted.**
5. On G1.2, I think the plan at the bottom of the page should be 2/1.2 and say Second Floor Life Safety Plan instead of First Floor.  
**Correct.**
6. A multitude of notes on the plans and in the specs refer to the contractor's responsibility to maintain continuity of services during the renovation. It

will be impossible to quantify all instances where we will need to maintain continuity of services. Is it possible to provide an allowance to cover the efforts to maintain continuity of services as they arise during the renovation?

No allowance will be provided. Existing units are to remain operational as long as possible during construction and new equipment to be operational early in the project (end of Phase 2). Contractor responsible to provide temporary heating and cooling to the extent required to maintain the occupied space above 60 degrees F and below 80 degrees F.

7. On the demolition drawings, I have not found Demolition Key Note D-36. I think it should go at the corridor of Open Office 103 on A2.1. Also, what is shown on the wall to be demo'd in Corridor C110A?

D-36 should point to the door, sidelite, and wall in Open Office 103. The items to be disconnect and demolished are the automatic door push button, with attached closer above door and signage. See update drawing.

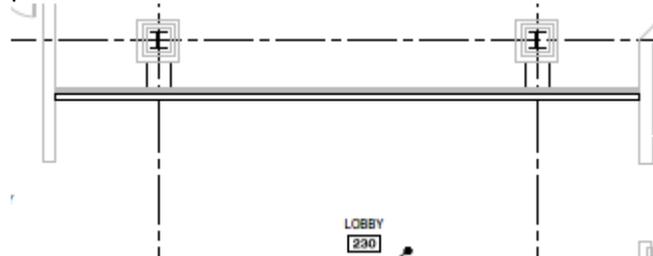
8. The Construction Key Note C-12 says "not in use" but I see one in Fire Comm. Cntr. 000C on A3.1.

That note should be C-09 referring to new flooring.

9. On A3.1 in Vestibule 000B behind the new cabinet unit heater, it looks like some new partition, type P1 perhaps?

Yes P1.

10. On A3.2, what is being depicted here that looks kind of like a new partition?



New baseboard, similar to south wall.

11. I see on drawing A4.4 Airolite is mentioned. There doesn't appear to be a specification at the moment.

No specifications provided, sunshade to be Airolite TSC4 Sun Shade.

12. Drawing 9.11 detail 2 shows 1 new 225 amp plug in breaker and 1 new 200 amp plug in breaker to be installed on existing PE Busduct – 1600 amp, 480/277V, 3PH/4W (located in intermediate mechanical level), for connections to new panel PPH-G1 and new 150 KVA transformer/panels DPL-GA & DPL-G1.

It was determined at the 8/17/18 site visit that the Busduct located in intermediate mechanical level does not have the capacity to install two new plug in breakers.

It was also determined that Carvel facilities would provide 2 Busduct plug in breaker enclosures without breakers.

Please provide Busduct locations to install new 225 amp and 200 amp plug in breakers.

Please provide information/requirements to retrofit new breakers into owner supplied plug in breaker enclosures.

**See revised drawings in addendum #2. 4<sup>th</sup> floor busduct to be used for new plug in breakers.**

13. Please provide existing fire alarm vendor information for the Carvel Building.

**The FA system at Carvel is an older Notifier system. Of all the vendors who have serviced it only Kratos has been successful. Although “technically” anyone qualified should be able to work on it our experience has been to only use Kratos.**

14. Key Note C-11 on Drawing A3.6 says that we are to provide the Dunkin Donuts wall-mounted signage. Wouldn't this be provided by the franchise owner?

**Disregard keynote C-11 on A3.6.**

15. Please provide a hardware spec and schedule.

**See allowance form.**

16. Please clarify the intent of the construction of the temporary walls (i.e. metal or wood studs, drywall or plywood, finishing and/or painting). Also, what height is required?

**Partition height to underside of first floor ceiling, metal studs and drywall, tape seam, prime and paint public side.**

17. The east ramp is not drawn the same when comparing A3.1 and A4.3, please clarify. Also, A4.3 shows wood framing at the lower portion of the east ramp. Is this required?

**No wood framing, see updated A4.3.**

18. Regarding note C-40 on A3.2, please confirm that the TV will be furnished by the owner.

**It is confirmed TV is to be furnished by owner, installed by contractor.**

19. Regarding the work at Dunkin Donuts on A3.6:

- a. C-02, C-03, and C-10: Please provide details and sections for the casework or kitchen equipment that is supposed to be provided by the GC.

**Casework and kitchen equipment is not in contract.**

- b. C-04: Please provide shelving details and/or specs, if this is supposed to be provided by the GC.

**Shelving not in contract.**

- c. C-05: Please provide door hardware information.

**See attached.**

- d. C-11: It was stated at the Prebid meeting that Dunkin Donut signage would not be in this contract. If it is supposed to be by the GC, please provide information for pricing.

**Not in contract.**

20. Note C-26 call for a wall mount for a police shield. Please clarify what is meant by “wall mount”.  
**Contractor to provide 24” wide x 3” x 3”x 5/16” painted steel angle epoxy anchored to substrate at 12” o.c.**
21. Drawing A3.1 shows detail X/AX.X in vestibule 000A. Please provide this detail.  
**See detail on drawing 6/A3.5.**
22. Please clarify the height of the ceramic tile wall finish in Toilet 103A.  
**See drawing A3.5.**
23. Please clarify if there should be any toilet accessories included for Toilet 103A.  
**See drawing A3.5.**
24. Fire extinguishers and fire extinguisher cabinets are not indicated on the drawings. Please provide all locations.  
**See drawing A3.1 for locations.**
25. 101400 Signage, are new door signs required at new doors, only, as per Door Schedule on Sheet A6.1, or at all doors as indicated on plans?  
**See drawing A3.1 for locations.**
26. Are new door signs required at all stair entrances?  
**No.**
27. 101400 Signage, Part 2.04 Dimensional Letter for Walls, there are no locations at the walls indicated on the drawings. Please clarify.  
**Dimension letter for walls are located at half wall by Vestibule 000A and Storefront SF1.**
28. At Elevation 2/A6.1 are the “raised letters for signage” dimensional letters as specified in Section 101400? The font type shown on the elevation is not Perpetua Bold as per specs.  
**Font will be selected from manufacturer’s range.**

**END**

**ALLOWANCE AUTHORIZATION**

**Project:** Carvel Building Lobby Renovations

**Architect:** StudioJAED Architects & Engineers

**Project No.** MC1002000393

**Contractor:**

**AAA No.:**

**Initiation Date:**

**The Allowance is allocated as follows:**

- Allowance No. 1: \$50,000 for General Contingencies and Repairs.
- Allowance No. 2: \$20,000 for Security/IT Scope.
- Allowance No. 3: \$12,000 for Door Hardware Material Only.
- Allowance No. 4: \$3,500 for Graphic FRP Material Only.

Total original Contract Allowance was: \$ 82,000.00  
 Amount of Contract Allowance Access previously authorized: \$  
 Adjusted Contract Allowance prior to this authorization is: \$  
 The amount of available Allowance will Decrease by this Access Authorization: \$  
 The remaining Contract Allowance, after this Access Authorization will be: \$

**Recommended by:  
Architect**

By (Signature): \_\_\_\_\_

Date: \_\_\_\_\_

**Accepted by:  
Contractor**

By (Signature): \_\_\_\_\_

Date: \_\_\_\_\_

**Approved by:  
Owner**

By (Signature): \_\_\_\_\_

Date: \_\_\_\_\_

**SECTION 01 79 00**  
**DEMONSTRATION AND TRAINING****PART 1 GENERAL****1.01 SUMMARY**

- A. Demonstration of products and systems where indicated in specific specification sections.
- B. Training of State of Delaware OMB - Division of Facilities Management personnel in operation and maintenance is required for:
  - 1. All software-operated systems.
  - 2. HVAC systems and equipment.
  - 3. Plumbing equipment.
  - 4. Electrical systems and equipment.
  - 5. Items specified in individual product Sections.
- C. Training of State of Delaware OMB - Division of Facilities Management personnel in care, cleaning, maintenance, and repair is required for:
  - 1. Items specified in individual product Sections.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 78 00 - Closeout Submittals: Operation and maintenance manuals.
- B. Section 01 91 13 - General Commissioning Requirements: Additional requirements applicable to demonstration and training.

**1.03 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Training Plan: State of Delaware OMB - Division of Facilities Management will designate personnel to be trained; tailor training to needs and skill-level of attendees.
  - 1. Submit to DEDC, LLC for transmittal to State of Delaware OMB - Division of Facilities Management.
  - 2. Submit not less than four weeks prior to start of training.
  - 3. Revise and resubmit until acceptable.
  - 4. Provide an overall schedule showing all training sessions.
  - 5. Include at least the following for each training session:
    - a. Identification, date, time, and duration.
    - b. Description of products and/or systems to be covered.
    - c. Name of firm and person conducting training; include qualifications.
    - d. Intended audience, such as job description.
    - e. Objectives of training and suggested methods of ensuring adequate training.
    - f. Methods to be used, such as classroom lecture, live demonstrations, hands-on, etc.
    - g. Media to be used, such as slides, hand-outs, etc.
    - h. Training equipment required, such as projector, projection screen, etc., to be provided by Contractor.
- C. Training Manuals: Provide training manual for each attendee; allow for minimum of two attendees per training session.
  - 1. Include applicable portion of O&M manuals.
  - 2. Include copies of all hand-outs, slides, overheads, video presentations, etc., that are not included in O&M manuals.
  - 3. Provide one extra copy of each training manual to be included with operation and maintenance data.
- D. Training Reports:
  - 1. Identification of each training session, date, time, and duration.
  - 2. Sign-in sheet showing names and job titles of attendees.

3. List of attendee questions and written answers given, including copies of and references to supporting documentation required for clarification; include answers to questions that could not be answered in original training session.
- E. Video Recordings: Submit digital video recording of each demonstration and training session for State of Delaware OMB - Division of Facilities Management's subsequent use.
1. Format: DVD Disc.
  2. Label each disc and container with session identification and date.

#### **1.04 QUALITY ASSURANCE**

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
  2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

### **PART 2 PRODUCTS - NOT USED**

### **PART 3 EXECUTION**

#### **3.01 DEMONSTRATION - GENERAL**

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by State of Delaware OMB - Division of Facilities Management.
- B. Demonstration may be combined with State of Delaware OMB - Division of Facilities Management personnel training if applicable.
- C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
1. Perform demonstrations not less than two weeks prior to Substantial Completion.
  2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
1. Perform demonstrations not less than two weeks prior to Substantial Completion.

#### **3.02 TRAINING - GENERAL**

- A. Conduct training on-site unless otherwise indicated.
- B. State of Delaware OMB - Division of Facilities Management will provide classroom and seating at no cost to Contractor.
- C. Provide training in minimum two hour segments.
- D. Training schedule will be subject to availability of State of Delaware OMB - Division of Facilities Management's personnel to be trained; re-schedule training sessions as required by State of Delaware OMB - Division of Facilities Management; once schedule has been approved by State of Delaware OMB - Division of Facilities Management failure to conduct sessions according to schedule will be cause for State of Delaware OMB - Division of Facilities Management to charge Contractor for personnel "show-up" time.
- E. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
1. The location of the O&M manuals and procedures for use and preservation; backup copies.
  2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
  3. Typical uses of the O&M manuals.
- F. Product- and System-Specific Training:

1. Review the applicable O&M manuals.
  2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
  3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
  4. Provide hands-on training on all operational modes possible and preventive maintenance.
  5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
  6. Discuss common troubleshooting problems and solutions.
  7. Discuss any peculiarities of equipment installation or operation.
  8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
  9. Review recommended tools and spare parts inventory suggestions of manufacturers.
  10. Review spare parts and tools required to be furnished by Contractor.
  11. Review spare parts suppliers and sources and procurement procedures.
- G. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

**END OF SECTION**



**SECTION 03 35 33**  
**STAMPED CONCRETE**

**PART 1 GENERAL**

**1.1 SECTION INCLUDES**

- A. Stamped concrete.

**1.2 RELATED REQUIREMENTS**

- A. Section 03 30 00 – Cast-in-Place Concrete.

**1.3 REFERENCE STANDARDS**

- A. ASTM C 309 – Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
- B. ASTM C 979 – Standard Specification for Pigments for Integrally Colored Concrete.

**1.4 SUBMITTALS**

- A. Comply with Section 01 33 00 – Submittal Procedures.
- B. Product Data: Submit manufacturer's product data, including preparation and application instructions.
- C. Samples: Submit manufacturer's samples of standard colors.
- D. Manufacturer's Certification: Submit manufacturer's certification that materials comply with specified requirements and are suitable for intended application.
- E. Applicator's Project References: Submit applicator's list of successfully completed stamped concrete projects, including project name and location, name of architect, and type and quantity of materials applied.

**1.5 QUALITY ASSURANCE**

- A. Applicator's Qualifications:
  - 1. Applicator regularly engaged, for preceding 5 years, in application of stamped concrete of similar type to that specified.
  - 2. Employ persons trained for application of stamped concrete.
- B. Mock-ups:
  - 1. Construct Mock-ups of Stamped Concrete:
    - a. Use same materials and methods for use in the Work.
    - b. Location: Determined by Architect.
    - c. Minimum Size: 4 feet by 4 feet.

2. Receive approval of mock-ups by Architect for patterns, colors, textures, finishing, curing, cleaning, sealing, special effects, and workmanship before application of stamped concrete.
3. Approved Mock-ups:
  - a. Standard for patterns, colors, textures, finishing, curing, sealing, special effects, and workmanship of stamped concrete.
  - b. Retain through completion of Work for use as quality standard.

C. Pre-application Meeting:

1. Convene pre-application meeting before start of application of stamped concrete.
2. Require attendance of parties directly affecting work of this section, including:
  - a. Contractor.
  - b. Architect.
  - c. Landscape architect.
  - d. Applicator.
  - e. Manufacturer's representative.
3. Review:
  - a. Mock-ups.
  - b. Materials.
  - c. Preparation.
  - d. Application.
  - e. Finishing.
  - f. Curing.
  - g. Cleaning.
  - h. Sealing.
  - i. Protection.
  - j. Coordination with other work.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Delivery and Acceptance Requirements: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage and Handling Requirements:
  1. Store and handle materials in accordance with manufacturer's instructions.
  2. Keep materials in manufacturer's original, unopened containers and packaging until application.
  3. Store materials in clean, dry area indoors.
  4. Store materials out of direct sunlight.
  5. Keep materials from freezing.
  6. Protect materials during storage, handling, and application to prevent contamination or damage.

## 1.7 AMBIENT CONDITIONS

- A. Apply materials when air and surface temperatures are between 55 degrees F (13 degrees C) and 80 degrees F (27 degrees C).
- B. Do not apply materials when rain, snow, or excessive moisture is expected during application or within 24 hours after application.

## **PART 2 PRODUCTS**

### **2.1 MANUFACTURER**

- A. Brickform, 11061 Jersey Boulevard, Rancho Cucamonga, California 91730. Toll Free 800-483-9628. Phone 909-484-3399. Fax 909-484-3318. Website [www.brickform.com](http://www.brickform.com). E-mail [info@brickform.com](mailto:info@brickform.com).

### **2.2 MATERIALS**

- A. Concrete Topping and Hardener: Brickform "Color Hardener".
  - 1. Color: Standard range.
    - a. Application Rate: Per manufacturer recommendations.
- B. Liquid Integral Concrete Color: Brickform "Liquid Color".
  - 1. Compliance: ASTM C 979.
  - 2. Color: Standard range
- E. Colorless Bond Breaker: Brickform "Liquid Release".
- F. Stamping Mats: Brickform "Creative Image Mats".
  - 1. Pattern: Standard patterns
- G. Curing Compound:
  - 1. Clear, non-yellowing, non-staining, breathable, UV stable.
  - 2. Compliance: ASTM C 309.
  - 3. Compatible with colored concrete.
- H. Concrete Cleaner: Brickform "Antique Release/Efflorescence Remover".
  - 1. Biodegradable.
- I. Sealer:
  - 1. Satin-Finish Sealer: Brickform "Satin-Seal".
    - a. Natural-look, water-based, acrylic, clear sealer.
    - b. VOC: 100 g/L.

## **PART 3 EXECUTION**

### **3.1 EXAMINATION**

- A. Examine surfaces to receive stamped concrete.
- B. Notify Architect of conditions that would adversely affect application or subsequent use.

- C. Do not begin preparation or application until unacceptable conditions are corrected.

### **3.2 PREPARATION**

- A. Protection of In-Place Conditions: Protect adjacent surfaces, areas, adjoining walls, and landscaping from contact with stamped concrete materials.
- B. Preparation of Subgrade:
  - 1. Ensure subgrade is uniformly graded, compacted, and moistened.
  - 2. Ensure subgrade is free of standing water.
  - 3. Do not place concrete over soft, frozen, or muddy subgrade.
- C. Concrete:
  - 1. Specified in Section 03 30 00, unless otherwise specified in this section.
  - 2. Cement Content: As recommended by manufacturer.
  - 3. Slump: Maximum 4 inches.
  - 4. Calcium Chloride: Do not use calcium chloride or admixtures containing calcium chloride.
  - 5. Fine and Course Aggregates:
    - a. Non-reactive.
    - b. Free of deleterious material.

### **3.3 APPLICATION**

- A. Apply stamped concrete materials in accordance with manufacturer's instructions at locations indicated on the Drawings.
- C. Integrally Colored Concrete: Design mix, batch, add colorant, place, finish, and cure concrete in accordance with integral concrete color manufacturer's instructions.
- E. Colorless Bond Breaker:
  - 1. Apply colorless bond breaker in accordance with manufacturer's instructions to bottom of stamping mats and on concrete surface, when concrete has reached plastic stage desirable for imprinting.
  - 2. Do not trowel or mix colorless bond breaker into plastic concrete surface.
- F. Stamping Mats:
  - 1. Press stamping mats in accordance with manufacturer's instructions into concrete that has reached plastic stage desirable for imprinting.
  - 2. Use stamping mats to create patterns in concrete as indicated on the Drawings.
- G. Approved Mock-ups: Match approved mock-ups for patterns, colors, textures, finishing, curing, cleaning, sealing, special effects, and workmanship.

### **3.4 CURING**

- A. Cure concrete in accordance with manufacturer's instructions.
- B. Apply curing compound in accordance with manufacturer's instructions.
- C. Do not cure concrete using materials or methods harmful to concrete surface, including:
  - 1. Low-pressure or high-pressure steam.

2. Burlap.
3. Plastic sheeting.
4. Membrane paper.
5. Water misting.
6. Sodium-silicone-type hardeners.

### **3.5 CLEANING**

- A. Clean concrete in accordance with manufacturer's instructions.
- B. Apply concrete cleaner in accordance with manufacturer's instructions to remove:
  1. Excess colored bond breaker/antiquing release agent.
  2. Efflorescence.
  3. Cement scale.
- C. Apply concrete cleaner before sealing concrete surface.

### **3.6 SEALING**

- A. Seal concrete surfaces in accordance with manufacturer's instructions.
- B. Apply sealer to clean and dry concrete surfaces in accordance with manufacturer's instructions after concrete has cured a minimum of 28 days.
- C. Apply sealer uniformly over entire stamped concrete surface.
- D. Do not allow traffic on finished sealed surfaces for the following periods after application:
  1. Foot Traffic: Minimum 24 hours.
  2. Heavy Traffic: Minimum 72 hours.

### **3.7 PROTECTION**

- A. Exterior Surfaces: Protect applied stamped concrete to ensure that, except for normal weathering, concrete will be without damage or deterioration at time of Substantial Completion.

**END OF SECTION**

SECTION 09 77 16  
FRAMED DECORATIVE PANEL SYSTEM

PART 1 GENERAL

1.1 SUMMARY

- A. Section Includes: This Section specifies decorative prefinished panel with pre-engineered attachment clip, along with hardware and trim systems for installation directly to studs or solid substrate and may include:
  - 1. High pressure laminate of fiber board substrate panels.
  - 5. Hardware.

1.2 REFERENCES

- A. Reference Standards:
  - 1. American National Standards Institute (ANSI)
    - a. ANSI A208.2 Medium Density Fiberboard (MDF) for Interior Applications.
  - 2. Architectural Woodwork Institute (AWI)
    - a. Architectural Woodwork Standards, 2nd Edition.
  - 3. Architectural Woodwork Manufacturer's Association of Canada (AWMAC)
    - a. Architectural Woodwork Standards, 2nd Edition.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
  - 1. Locate trim members to ensure panel lines coordinate with doors, headers, jambs and other discontinuities in walls.
  - 3. Coordinate delivery of framed decorative panel system materials to casework fabricator for incorporation into casework.
    - a. Ensure materials are clearly marked related to project and casework location.

1.4 SUBMITTALS

- A. Make submittals in accordance with Section 01 33 00 - Submittal Procedures.
- B. Product Data: Manufacturer's standard specifications and descriptive literature, including:
  - 1. Product characteristics
  - 2. Safety Data Sheets (SDS) for adhesives, sealants and other pertinent materials prior to delivery to site.
- C. Shop Drawings: Submit elevations of each wall showing location of paneling and trim members with respect to discontinuities in wall elevation.
- D. Samples:
  - 1. Samples for Selection: Submit manufacturer's standard color and pattern selection samples representing manufacturer's full range of available colors and patterns.
- E. Manufacturer's written instructions, including:
  - 1. Delivery, storage and handling recommendations.
  - 2. Preparation and installation recommendations.
- F. Test Reports: Certified test reports showing compliance with specified performance characteristics and physical properties.
- G. Certificates: Product certificates signed by manufacturer certifying materials comply with specified performance characteristics and criteria, and physical requirements.
- H. Manufacturer's Field Reports: Submit manufacturer's field reports within 3 days of each manufacturer representative's site visit and inspection.
- I. Installer's Experience: Submit verification of evidence of work similar to the work of this Section.
- J. Warranty: Fully executed, issued in [Owner's] name and registered with manufacturer, including:
  - 1. Manufacturer's [30-day] warranty covering defects in materials.

## 1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Supply maintenance data for framed decorative panel system for incorporation into manual specified in Section 01 78 00 Closeout Submittals.
- B. Record Documentation: In accordance with Section 01 78 00 Closeout Submittals.
  - 1. List materials used in framed decorative panel system work.
  - 2. Warranty: Submit warranty documents specified.

## 1.6 QUALITY ASSURANCE

- A. Installer: Experienced in performing work similar to work of this Section.

## 1.7 DELIVERY, STORAGE & HANDLING

- A. Deliver materials in accordance with manufacturer's written instructions.
  - 1. Deliver materials on strong pallets in manufacturer's original, unopened, undamaged containers with identification labels intact and product name and manufacturer clearly visible and in sizes to suit project.
  - 2. Inspect each package for damage and promptly contact Marlite, Inc. directly to report damaged packages or missing components
- B. Store materials in manufacturer's unopened packaging until ready for installation.
  - 1. Maintain temperature range of 60° to 80°F and humidity range of 35 to 55 % during storage, installation and product life cycle.
  - 2. Maintain plastic or other protective wrap in place during on site handling until ready for installation.
  - 3. Keep panels clean and do not stack panels after removal of protection.
- C. Store and dispose of solvent-based materials, and materials used with solvent-based materials, in accordance with requirements of local authorities having jurisdiction.

## 1.8 FIELD CONDITIONS

- A. Do not use wood or fiber board products in kitchens, rest rooms, or other high humidity areas.
- B. Maintain environmental conditions (temperature, humidity and ventilation) within limits in accordance with manufacturer's written recommendations for optimum results.
  - 1. Do not install products under environmental conditions outside manufacturer's absolute limits.

## 1.9 WARRANTY

- A. Project Warranty: Refer to Contract Conditions for project warranty provisions.
- B. Manufacturer's warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official.
  - 1. Manufacturer's warranty is in addition to and not intended to limit other rights Owner may have under Contract Conditions.

## PART 2 PRODUCTS

### 2.1 MANUFACTURER

- A. Marlite, Inc.
- B. Contact Information: 1 Marlite Drive, Dover, Ohio 44622; Phone: (330) 343-6621, Phone: (800) 377-1221; FAX: (330) 343-7296; Email: info@marlite.com; Website: www.marlite.com.
- C. Acceptable Material: Marlite Surface Systems MAP.

### 2.2 PERFORMANCE REQUIREMENTS

- A. Burn Characteristics to ASTM E84, Class A.
  - 1. Flame spread: 0-25.
  - 2. Smoke Developed 0-450.
- B. Burn Characteristics to ASTM E84, Class C.
  - 1. Flame spread: 76-200.
  - 2. Smoke Developed 0-450.

## 2.3 DESCRIPTION

- A. Clip-on 3/4 inch thick decorative wall panel system.

## 2.4 HARDWARE

- A. Panel Trim:
  - 1. Reveal:
    - a. Horizontal: 1/4 inch narrow
    - b. Vertical: 1/4 inch narrow
- B. Hardware and Trim Material:
  - 1. Aluminum - Heavy weight extruded aluminum 6063-T5 alloy and factory prefinished
    - a. Main rail: 1/4 inch narrow
    - b. Cross spline: 1/4 inch narrow
    - c. Concealed aluminum: Mill finished
    - d. Exposed aluminum: Black satin anodized

## 2.5 PANELS

- A. Panel Configuration: Size varies.
  - 1. Maximum of 48 inches along unsupported frame
  - 2. Panel thickness: 3/4 inches maximum.
- B. Wood Fiber Substrate:
  - 1. Medium density wood fiberboard, 3/4 inch, conforming to ANSI A208.2, industrial-grade MDF or other wood fiber substrates and having no added formaldehyde.
- C. High Pressure Laminate Panels: Vertical grade high pressure plastic laminate adhered to wood fiber substrate.
  - 1. Balancing Backer: Kraft paper that does not contribute to or pose additional fire hazard.
  - 2. Color and pattern: As selected by Architect from manufacturer's standard range.
  - 3. Acceptable Material: Marlite High Pressure Laminate Panels.

## 2.6 ACCESSORIES

- A. Adhesives: Solvent based low VOC adhesive.
  - 1. Acceptable Material: Marlite C-109 Solvent Based Adhesive.

## 2.7 FABRICATION

- A. Ensure framing panels, hardware and accessories are factory finished and ready to install except for field fabrication as required at work site and perimeter conditions.
  - 1. Refinish field cut panel edges in accordance with manufacturer's instruction before installation.
  - 2. Drill corners for cut-outs 1/8 inch radius minimum.

## PART 3 EXECUTION

### 3.1 INSTALLER

- A. Use only installers who have training and experience of work similar to the work of this Section.

### 3.2 EXAMINATION

- A. Verification of Conditions: Verify that conditions of substrate previously installed under other Sections or Contracts are acceptable for framed decorative panel system installation in accordance with manufacturer's written recommendations.
  - 1. Visually inspect substrate in presence of Architect.
  - 2. Ensure substrate is smooth, sound, clean, dry and free of contaminants and other deleterious materials.
  - 3. Ensure vapor barrier has been provided on exterior walls behind backing to prevent warping.
  - 4. Ensure backing panels are smooth, solid, and flat and that drywall joints are taped and finished.
  - 5. Ensure walls are primed before installation begins.
  - 6. Ensure mechanical, electrical and building service or items affecting work of this section are placed and ready to receive this work.

REVISED PER ADDENDUM #2

7. Ensure stud spacing does not exceed 24 inches.
  8. Inform Architect of unacceptable conditions immediately upon discovery.
  9. Proceed with installation only after unacceptable conditions have been remedied and after receipt of written approval to proceed from Architect.
  10. Starting installation of framed decorative panel system implies substrate conditions are acceptable for work of this section.
- B. Ensure structural walls are finished and building is completely closed with walls thoroughly dry before starting installation.

3.3 PREPARATION

- A. Conditioning: Allow panels to acclimate to balanced environment in installation location for 72 hours minimum before and during installation.
1. Maintain environmental conditions of 60° to 80° F and 35% to 55% humidity in installation location for 72 hours before and during installation.
- B. Protect existing surfaces with drop cloths.
- C. Except as indicated, before installing, examine panels and arrange to achieve best combination of color, pattern, texture and grain.
- D. Ensure HVAC system is operable and installation area is balanced to normal operating conditions before proceeding with installation.

3.4 INSTALLATION

- A. Install framed decorative panel system in accordance with manufacturer's written recommendations.
- B. Install materials straight, plumb and level in accordance with manufacturer's written instructions.
1. Anchor units tightly and securely in place.
  2. Cut sheets to meet existing supports.
- C. Fasten supports and trim using #6 trim-head screws anchored into stud or other solid substrate at 16 inch centers.
1. Where screws do not hit studs, fasten with adhesive in accordance with manufacturer's written recommendations.
  2. Pre-drill holes through members and fasten screw flush with flange on aluminum profile.
  3. Where necessary countersink for screw head to seat flush with flange.
- D. Avoid contamination of the panel faces with adhesives, solvents or cleaners during installation.
1. Clean up spills immediately.

3.5 FIELD QUALITY CONTROL

- A. Field Inspection: Coordinate field inspection in accordance with Section 01 45 00 Quality Control.

3.6 CLEANING

- A. Perform daily progress cleaning.
1. Leave work area clean at end of each day.
- B. Upon completion, remove surplus materials, rubbish, tools and equipment.
- C. Collect recyclable waste and dispose of in accordance with manufacturer's written recommendations and at appropriate recycling facilities.

3.7 PROTECTION

- A. Protect installed framed decorative panel system from damage during construction.
- B. Repair or replace adjacent materials damaged by installation of framed decorative panel system.

END OF SECTION

**SECTION 10 28 13**

**TOILET ACCESSORIES**

**PART 1 GENERAL**

**1.01 SECTION INCLUDES**

- A. Toilet Room Accessories.

**1.02 RELATED SECTIONS**

- A. Section 09 21 16 - Gypsum Board Assemblies.

**1.03 REFERENCES**

- A. ATBCB ADAAG - Americans with Disabilities Act Accessibility Guidelines; US Architectural and Transportation Barriers Compliance Board.
- B. ASTM A 240/A 240M - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- C. ASTM A 554 - Standard Specification for Welded Stainless Steel Mechanical Tubing.
- D. ASTM C 1036 - Standard Specification for Flat Glass.
- E. ASTM F 446 - Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's product data for products specified, indicating selected options and accessories.
- C. Shop Drawings:
  - 1. Plans: Locate each specified unit in project.
  - 2. Elevations: Indicate mounting height of each specified unit in project.
  - 3. Details: Indicate anchoring and fastening details, required locations and types of anchors and reinforcement, and materials required for correct installation of specified products not supplied by manufacturer of products of this section.
- D. Verification Samples: Two samples of each specified finish.
- E. Quality Assurance Submittals:
  - 1. Manufacturer's printed installation instructions for each specified product.
  - 2. Documentation of manufacturer's qualifications, specified in QUALITY ASSURANCE Article of this section.
- F. Closeout Submittals: Warranty documents, issued and executed by manufacturer of products of this section, and countersigned by Contractor.

**1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Minimum five (5) years of documented experience producing products of the types specified in this section.

- B. Regulatory Requirements: Conform to ADAAG requirements.

#### **1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Factory-apply strippable protective vinyl coating to sight-exposed surfaces after finishing of products; ship products in manufacturer's standard protective packaging.
- B. Storage and Protection: Store products in manufacturer's protective packaging until installation.

#### **1.07 SEQUENCING**

- A. Supply locating and sizing templates, and other requirements, to fabricators and installers of products referenced in RELATED SECTIONS Article for building in products of this section.
- B. Supply reinforcing and anchoring devices required for installation of products of this section to fabricators and installers of products referenced in RELATED SECTIONS Article.

#### **1.08 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's standard warranty against defects in product workmanship and materials.
- C. Manufacturer's 15-year warranty against silver spoilage of mirrors.

### **PART 2 PRODUCTS**

#### **2.01 MANUFACTURERS**

- A. Acceptable Manufacturers:
  - 1. Bobrick Washroom Accessories (Design Basis)
  - 2. Bradley Corp.
  - 3. ASI-American Specialties, Inc.
- B. Substitutions: Section 01 60 00 - Product Requirements.

#### **2.02 MATERIALS**

- A. Stainless Steel Sheet: ASTM A 240/A 240M, Type 304, 18-8 alloy.
- B. Sheet Steel, chrome plated.

#### **2.03 TOILET ACCESSORIES**

- A. Basic Construction Requirements:
  - 1. Hinges: Stainless steel piano hinge, 3/16 inch diameter barrel, full length of cabinet; hinge leaves spot-welded to door and cabinet body.
  - 2. Locks: Tumbler locks, keyed alike other toilet accessory locks, with two keys for each lock.
  - 3. Stainless Steel Finish: No.4 satin, typical unless noted otherwise.

### **PART 3 EXECUTION**

#### **3.01 EXAMINATION**

- A. Verification of Conditions:
  - 1. Prepared openings are sized and located in accordance with shop drawings.
  - 2. Reinforcement and anchoring devices are correct type and are located in accordance with shop drawings.

- B. Installer's Examination:
1. Have installer of this section examine conditions under which construction activities of this section are to be performed, then submit written notification if such conditions are unacceptable.
  2. Transmit two copies of installer's report to StudioJAED within 24 hours of receipt.
  3. Beginning construction activities of this section before unacceptable conditions have been corrected is prohibited.
  4. Beginning construction activities of this section indicates installer's acceptance of conditions.

### 3.02 INSTALLATION

- A. Install toilet accessories plumb and level in accordance with shop drawings and manufacturer's printed installation instructions.
- B. Locate toilet accessories at heights specified by Americans with Disabilities Act (ADA).

### 3.03 CLEANING

- A. Remove manufacturer's protective vinyl coating from sight-exposed surfaces 24 hours before final inspection.
- B. Clean surfaces in accordance with manufacturer's recommendations.

### 3.04 PROTECTION OF INSTALLED PRODUCTS

- A. Protect products from damage caused by subsequent construction activities.
- B. Field repair of damaged product finishes is prohibited; replace products having damaged finishes caused by subsequent construction activities.

## END OF SECTION

## SCHEDULE

### MIRRORS

- a. STAINLESS STEEL CHANNEL FRAME
- b. 24" X 36" (ACCESSIBLE STALL) AND 60" X 36" (VANITY)
- c. BASIS OF DESIGN: BOBRICK B-165 (WITH SHELF = B-166)

### GRAB BARS

- a. HEAVY DUTY, COMMERCIAL GRADE
- b. BRUSHED STAINLESS STEEL, TYPE 304, 18 GAUGE
- c. 1 ½" DIAMETER
- d. 1 ½" SPACE BETWEEN WALL WHEN MOUNTED
- e. WITH CONCEALED SET SCREW FLANGE

### SOAP DISPENSER

- a. FOAM DISPENSER
- b. PLASTIC COVER
- c. WALL MOUNT

### PAPER TOWEL DISPENSER

- a. SURFACE MOUNTED ROLL PAPER TOWEL DISPENSER
- b. PLASTIC CONSTRUCTION, TRANSLUCENT COVER
- c. LOCKING CABINET
- d. UNIVERSAL ROLL COMPATIBLE
- e. ACCEPT ECONOMICALLY PRICED, UNIVERSAL, NON PERFORATED, NON PROPRIETARY ROLL PAPER TOWELS 8" DIAMETER, 8" WIDE, 800' LONG WITH 1 ½" TO 2" DIAMETER STANDARD CORE

### TOILET PAPER DISPENSER

- a. SINGLE JUMBO ROLL
- b. PLASTIC COVER, SIMILAR TO 10TH FLOOR RESTROOMS

TOILET ACCESSORIES

**SECTION 23 05 93**  
**TESTING, ADJUSTING, AND BALANCING FOR HVAC**

**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Testing, adjustment, and balancing of air systems. Related to duct leak testing.
  - 1. The State of Delaware has a separate contract with Noresco Sustainability Services to perform final testing, adjusting, and balancing of this project. The successful contractor shall engage the services of a balancer to perform duct leak testing as specified in 23 31 00.

**1.02 RELATED REQUIREMENTS**

- A. Section 01 40 00 - Quality Requirements: Employment of testing agency and payment for services.
- B. Section 01 91 13 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- C. Section 23 31 00 - Air Duct Accessories.

**1.03 REFERENCE STANDARDS**

- A. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems; 2008.
- B. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems; 2015, Eighth Edition.
- C. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing; 2002.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Duct Leak Test Plan:
  - 1. The Duct Leak Test Plan shall include the following:
    - a. Marked up drawing identifying what ductwork will be leak tested.
    - b. Procedure for testing the identified ductwork. (How will this ductwork be temporarily sealed, etc)
    - c. Rating of the ductwork and what pressure this test will be conducted at.
- C. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
  - 1. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
  - 2. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
  - 3. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
  - 4. Units of Measure: Units of measure should include Inches of Water Column (In w.c.)
  - 5. Include the following on the title page of each report:
    - a. Name of Testing, Adjusting, and Balancing Agency.
    - b. Address of Testing, Adjusting, and Balancing Agency.
    - c. Telephone number of Testing, Adjusting, and Balancing Agency.
    - d. Project name.
    - e. Project location.
    - f. Project Engineer.
    - g. Project Contractor.
    - h. Report date.

**PART 2 PRODUCTS - NOT USED****PART 3 EXECUTION****3.01 GENERAL REQUIREMENTS**

- A. TAB contractor shall perform ductwork leak tests prior to installation of ceiling. TAB contractor shall schedule this work thru the mechanical contractor.
- B. Perform total system balance in accordance with one of the following:
  - 1. NEBB Procedural Standards for Testing Adjusting Balancing of Environmental Systems.
  - 2. SMACNA (TAB).
- C. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- D. Where HVAC systems and/or components interface with life safety systems, including fire and smoke detection, alarm, and control, coordinate scheduling and testing and inspection procedures with the authorities having jurisdiction.
- E. TAB Agency Qualifications:
  - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
  - 2. Certified by one of the following:
    - a. NEBB, National Environmental Balancing Bureau: [www.nebb.org](http://www.nebb.org).
    - b. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: [www.tabbcertified.org](http://www.tabbcertified.org).
- F. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

**3.02 EXAMINATION**

- A. Submit an explanation of the duct leakage test to the engineer. This
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.
- C. Beginning of work means acceptance of existing conditions.

**3.03 PREPARATION**

- A. Hold a pre-balancing meeting at least one week prior to starting TAB work.
  - 1. Require attendance by all installers whose work will be tested, adjusted, or balanced.
- B. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

**3.04 ADJUSTMENT TOLERANCES**

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

**3.05 RECORDING AND ADJUSTING**

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.

**3.06 SCOPE**

- A. Produce a Duct Leak Test Plan, Perform Duct Leak Testing, and report findings.

**3.07 MINIMUM DATA TO BE REPORTED**

- A. Duct Leak Tests:
  - 1. Description of ductwork under test
  - 2. Duct design operating pressure
  - 3. Duct design test static pressure
  - 4. Duct capacity, air flow
  - 5. Maximum allowable leakage duct capacity times leak factor
  - 6. Test apparatus
    - a. Blower
    - b. Orifice, tube size
    - c. Orifice size
    - d. Calibrated
  - 7. Test static pressure
  - 8. Test orifice differential pressure
  - 9. Leakage

**END OF SECTION**



**SECTION 23 07 19**  
**HVAC PIPING INSULATION****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.

**1.02 RELATED REQUIREMENTS**

- A. Section 07 84 00 - Firestopping.
- B. Section 23 21 13 - Hydronic Piping: Placement of hangers and hanger inserts.

**1.03 REFERENCE STANDARDS**

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate; 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric); 2014.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus; 2013.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form; 2016.
- E. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation; 2017.
- F. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel; 2008 (Reapproved 2013).
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
- H. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials; Current Edition, Including All Revisions.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

**1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years of documented experience.

**1.06 DELIVERY, STORAGE, AND HANDLING**

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

**1.07 FIELD CONDITIONS**

- A. Maintain ambient conditions required by manufacturers of each product.
- B. Maintain temperature before, during, and after installation for minimum of 24 hours.

**PART 2 PRODUCTS****2.01 REGULATORY REQUIREMENTS**

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

**2.02 GLASS FIBER**

- A. Manufacturers:
  - 1. Knauf Insulation: [www.knaufinsulation.com](http://www.knaufinsulation.com).
  - 2. Owens Corning Corp: [www.owenscorning.com](http://www.owenscorning.com).
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
  - 1. 'K' Value: ASTM C177, 0.24 at 75 degrees F.
  - 2. Maximum Service Temperature: 850 degrees F.
  - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Insulation: ASTM C547 and ASTM C795; semi-rigid, noncombustible, end grain adhered to jacket.
  - 1. Maximum Service Temperature: 650 degrees F.
  - 2. Maximum Moisture Absorption: 0.2 percent by volume.
- D. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.

**2.03 FLEXIBLE ELASTOMERIC CELLULAR INSULATION**

- A. Manufacturer:
  - 1. Armacell LLC; AP Armaflex: [www.armacell.us/#sle](http://www.armacell.us/#sle).
  - 2. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
  - 1. Minimum Service Temperature: Minus 40 degrees F.
  - 2. Maximum Service Temperature: 180 degrees F.
  - 3. Connection: Waterproof vapor barrier adhesive.

**2.04 JACKETS**

- A. PVC Plastic.
  - 1. Manufacturers:
    - a. Johns Manville Corporation: [www.jm.com](http://www.jm.com).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
  - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
    - a. Minimum Service Temperature: 0 degrees F.
    - b. Maximum Service Temperature: 150 degrees F.
    - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
    - d. Thickness: 10 mil.
    - e. Connections: Brush on welding adhesive.
- B. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
  - 1. Lagging Adhesive: Compatible with insulation.
- C. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
  - 1. Thickness: 0.016 inch sheet.
  - 2. Finish: Embossed.
  - 3. Joining: Longitudinal slip joints and 2 inch laps.
  - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
  - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

**2.05 REUSABLE VALVE COVER AND INSULATION**

- A. Manufacturers:
  - 1. No Sweat Valve Wraps, Inc.

2. ThermaXX LLC
  3. Substitutions: See Section 01 60 00 - Product Requirements.
- B. All valves, strainers, autoflow valves, circuit setters, ball valves, balancing valves and combination valves, etc., in chilled water, condenser water, and heating hot water systems, shall be insulated with a factory fabricated removable and reusable cover.
  - C. Insulation shall have a minimum k-factor .26, using fiberglass blanket. Flame and smoke spread shall be 25/50 per ASTM E-84.
  - D. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined by tabs made from hook and loop fasteners (Velcro). Butt ends shall have sewn-in-place elastic.
  - E. Outer jacket shall overlap adjoining sections of pipe insulation.
  - F. Installation shall not require the use of any special hand tools.
  - G. For fittings where operating temperature is below 45°F (7°C), or where the pipe insulation is greater than 1.5" (38mm), two or more layers of the insulation inserts are required beneath the valve cover surface.
  - H. Tychem QC should be limited and kept below 200°F (93°C) by use of proper insulation thickness.
  - I. Tychem QC should be kept away from contact with, or exposure to, sources of direct or radiated heat.
  - J. For fittings where operating temperatures exceed 250°F (121°C), or where pipe insulation is greater than 1.5" (38mm), two or more layers of the insulation inserts are required beneath the valve cover surface.

**PART 3 EXECUTION****3.01 EXAMINATION**

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

**3.02 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature; insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. Glass fiber insulated pipes conveying fluids below ambient temperature:
  1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
  2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- G. Glass fiber insulated pipes conveying fluids above ambient temperature.
  1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
  2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

- H. Inserts and Shields:
  - 1. Application: Piping 1-1/2 inches diameter or larger.
  - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
  - 3. Insert location: Between support shield and piping and under the finish jacket.
  - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 84 00.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.
- L. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

### 3.03 SCHEDULE

- A. Heating Systems:
  - 1. Heating Water Supply and Return: 2" Glass Fiber
- B. Cooling Systems:
  - 1. Chilled Water: 2" Glass Fiber
  - 2. Condenser Water: 2" Glass Fiber
  - 3. Heating Water Supply and Return: 2" Glass Fiber
  - 4. Condensate Drains from Cooling Coils: 1/2" Flexible Elastomeric Cellular Insulation
- C. Other Systems:
  - 1. Piping Exposed to Freezing with Heat Tracing: 2" glass fiber with aluminum jacketing
  - 2. Valves and other pipe appurtances: Provide reusable valve cover and insulation

**END OF SECTION**

**SECTION 23 09 50**  
**BUILDING AUTOMATION SYSTEM (BAS) GENERAL**

**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. General Requirements
- B. Description of Work
- C. Quality Assurance
- D. System Architecture
- E. Distributed Processing Units/Quantity and Location
- F. Demolition and Reuse of Existing Materials and Equipment
- G. Sequence of Work

**1.02 RELATED DOCUMENTS**

- A. Section 23 09 69 - Variable Frequency Controllers
- B. Section 23 09 51 - Building Automation System (BAS) Basic Materials, Interface Devices, and Sensors
- C. Section 23 09 53 - BAS Field Panels
- D. Section 23 09 54 - BAS Communication Devices
- E. Section 23 09 55 - BAS Software and Programming
- F. Section 23 09 58 - Sequences of Operation
- G. Section 23 09 59 - BAS Commissioning

**1.03 DESCRIPTION OF WORK**

- A. The building automation system (BAS) defined in this specification shall interface with the Delaware's State Network , and shall utilize the BACnet communication requirements as defined by ASHRAE/ANSI 135 (current version and addendum) for all communication.
- B. This system shall be an extension of the existing Johnson Control System currently installed in the building.
- C. The systems to be controlled under work of this section basically comprise new HVAC systems. The HVAC systems being controlled are Air Handling Units, VAV Systems, Boilers, Pumps, Exhaust Fans, and other devices. This Section defines the manner and method by which these controls function.

**1.04 APPLICATION OF OPEN PROTOCOLS**

- A. Subject to the detailed requirements provided throughout the specifications, the BAS and digital control and communications components installed, as work of this contract shall be an integrated distributed processing system utilizing BACnet. System components shall communicate using true BacNET in accordance with ASHRAE Standard 135 and current addenda and annexes, including all workstations, all building controllers, and all application specific controllers. Gateways to other communication protocols are not acceptable

**1.05 QUALITY ASSURANCE**

- A. Product Line Demonstrated History: The product line being proposed for the project must have an installed history of demonstrated satisfactory operation for a length of 2 years since date of final completion in at least 10 installations of comparative size and complexity. Submittals shall document this requirement with references.

The following requirement relates to the actual installing contractor.

- B. Installer's Qualifications: Firms specializing and experienced in control system installations for not less than 5 years. Firms with experience in BAS installation projects with point counts

equal to this project and systems of the same character as this project. If installer is a Value Added Reseller (VAR) of a manufacturer's product, installer must demonstrate at least three years prior experience with that manufacturer's products. Experience starts with awarded Final Completion of previous projects. Submittals must document this experience with references.

- C. Installer's Experience with Proposed Product Line: Firms shall have specialized in and be experienced with the installation of the proposed product line for not less than one year from date of final completion on at least 3 projects of similar size and complexity. Submittals shall document this experience with references.
- D. Installer's Field Coordinator and Sequence Programmer Qualifications: Individual(s) shall specialize in and be experienced with control system installation for not less than 5 years. Proposed field coordinator shall have experience with the installation of the proposed product line for not less than 2 projects of similar size and complexity. Installer shall submit the names of the proposed individual and at least one alternate for each duty. Submittals shall document this experience with references. The proposed individuals must show proof of the following training:
  - 1. Product Line Training: Individuals overseeing the installation and configuration of the proposed product line must provide evidence of the most advanced training offered by the Manufacturer on that product line for installation and configuration
  - 2. Programming Training: Individuals involved with programming the site-specific sequences shall provide evidence of the most advanced programming training offered by the vendor of the programming application offered by the Manufacturer.
- E. Installer's Service Qualifications: The installer must be experienced in control system operation, maintenance and service. Installer must document a minimum 5 year history of servicing installations of similar size and complexity. Installer must also document at least a one year history of servicing the proposed product line.
- F. Installer's Response Time and Proximity
  - 1. Installer must maintain a fully capable service facility within a 45 mile radius of the project site. Service facility shall manage the emergency service dispatches and maintain the inventory of spare parts.
  - 2. Emergency response times are listed below in this section. Installer must demonstrate the ability to meet the response times.

#### 1.06 CODES AND STANDARDS

- A. American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE)
  - 1. ASHRAE 135: BACnet - A Data Communication Protocol for Building Automation and Control Networks. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. current edition including all related addenda shall apply.
- B. Electronics Industries Alliance
  - 1. EIA-709.1-A-99: Control Network Protocol Specification
  - 2. EIA-709.3-99: Free-Topology Twisted-Pair Channel Specification
  - 3. EIA-232: Interface between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
  - 4. EIA-458: Standard Optical Fiber Material Classes and Preferred Sizes
  - 5. EIA-485: Standard for Electrical Characteristics of Generator and Receivers for use in Balanced Digital Multipoint Systems.
  - 6. EIA-472: General and Sectional Specifications for Fiber Optic Cable
  - 7. EIA-475: Generic and Sectional Specifications for Fiber Optic Connectors and all Sectional Specifications
  - 8. EIA-573: Generic and Sectional Specifications for Field Portable Polishing Device for Preparation Optical Fiber and all Sectional Specifications
  - 9. EIA-590: Standard for Physical Location and Protection of Below-Ground Fiber Optic Cable Plant and all Sectional Specifications

- C. Underwriters Laboratories
  - 1. UL 916: Energy Management Systems.  
The following rating is required only for devices used for smoke control purposes. If these are not intended, delete.
  - 2. UUKL 864: UL Supervised Smoke Control
- D. NEMA Compliance
  - 1. NEMA 250: Enclosure for Electrical Equipment
  - 2. NEMA ICS 1: General Standards for Industrial Controls.
- E. NFPA Compliance
  - 1. NFPA 90A "Standard for the Installation of Air Conditioning and Ventilating Systems" where applicable to controls and control sequences.
  - 2. NFPA 70 National Electrical Code (NEC)
- F. Institute of Electrical and Electronics Engineers (IEEE)
  - 1. IEEE 142: Recommended Practice for Grounding of Industrial and Commercial Power Systems
  - 2. IEEE 802.3: CSMA/CD (Ethernet - Based) LAN
  - 3. IEEE 802.4: Token Bus Working Group (ARCNET - Based) LAN

### 1.07 DEFINITIONS

- A. Advanced Application Controller (AAC): A device with limited resources relative to the Building Controller (BC). It may support a level of programming and may also be intended for application specific applications.
- B. Application Protocol Data Unit (APDU): A unit of data specified in an application protocol and consisting of application protocol control information and possible application user data (ISO 9545).
- C. Application Specific Controller (ASC): A device with limited resources relative to the Advanced Application Controller (AAC). It may support a level of programming and may also be intended for application-specific applications. .
- D. BACnet/BACnet Standard: BACnet communication requirements as defined by ASHRAE/ANSI 135 (Current edition and addendum).
- E. BACnet Interoperability Building Blocks (BIBB): A BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBS are combined to build the BACnet functional requirements for a device in a specification.
- F. Binding: In the general sense, binding refers to the associations or mappings of the sources network variable and their intended opr required destinations.
- G. Building Automation System (BAS): The entire integrated management and control system
- H. Building Controller (BC): A fully programmable device capable of carrying out a number of tasks including control and monitoring via direct digital control (DDC) of specific systems, acting as a communications router between the controlled devices / equipment and the CSS, and temporary data storage for trend information, time schedules, and alarm data.
- I. Change of Value (COV): An event that occurs when a measured or calculated analog value changes by a predefined amount (ASHRAE/ANSI 135 (current version and addendum)).
- J. Client: A device that is the requestor of services from a server. A client device makes requests of and receives responses from a server device.
- K. Continuous Monitoring: A sampling and recording of a variable based on time or change of state (e.g. trending an analog value, monitoring a binary change of state).
- L. Controller or Control Unit (CU): Intelligent stand-alone control device. Controller is a generic reference and shall include BCs, AACs, and ASCs as appropriate.

- M. Control Systems Server (CSS): A server class computer(s) that maintains the systems configuration and programming database. This server is located at the State of Delaware's data center in a virtual environment and serves as an access point to BAS.
- N. Controlling LAN: High speed, peer-to-peer controller LAN connecting BCs, AACs and ASCs. Refer to System Architecture below.
- O. Direct Digital Control (DDC): Microprocessor-based control including Analog/Digital conversion and program logic
- P. Functional Profile: A collection of variables required to define a the key parameters for a standard application. As this applies to the HVAC industry, this would include applications like VAV terminal, fan coil units, and the like.
- Q. Gateway (GTWY): A device, which contains two or more dissimilar networks/protocols, permitting information exchange between them.
- R. Hand Held Device (HHD): Manufacturer's microprocessor based device for direct connection to a Controller.
- S. LAN Interface Device (LANID): Device or function used to facilitate communication and sharing of data throughout the BAS
- T. Local Area Network (LAN): General term for a network segment within the architecture. Various types and functions of LANs are defined herein.
- U. Local Supervisory LAN: Also known as the State's Network: Ethernet-based network connecting Primary Controlling LANs with each other and OWSs and CSSs. See System Architecture below.
- V. Master-Slave/Token Passing (MS/TP): Data link protocol as defined by the BACnet standard.
- W. Open Database Connectivity (ODBC): An open standard application-programming interface (API) for accessing a database developed. ODBC compliant systems make it possible to access any data from any application, regardless of which database management system (DBMS) is handling the data.
- X. Operator Interface (OI): A device used by the operator to manage the BAS including OWSs, POTs, and HHDs.
- Y. Operator Workstation (OWS): The user's interface with the BAS system. As the BAS network devices are stand-alone, dedicated OWS is not required for communications to occur. The OWS can be any computer on the State's Network that has a compatible Web browser.
- Z. Point-to-Point (PTP): Serial communication as defined in the BACnet standard.
- AA. Portable Operators Terminal (POT): Mobile computer used both for direct connection to a controller as well as network connection.
- AB. Protocol Implementation Conformance Statement (PICS): A written document, created by the manufacturer of a device, which identifies the particular options specified by BACnet that are implemented in the device (ASHRAE/ANSI 135 (current version and addendum)).
- AC. Router: A device that connects two or more networks at the network layer.
- AD. Secondary Controlling LAN: LAN connecting AACs and ASCs, generally lower speed and less reliable than the Controlling LAN. Refer to System Architecture below.
- AE. Server : A device that is a provider of services to a client. A client device makes requests of and receives responses from a server device.
- AF. Standardized Query Language (SQL): A database computer language designed for managing data in relational database management system (RDBMS). Its scope includes data insert, query, update and delete, schema creation and modification, and data access control.

- AG. Smart Device: A control I/O device such as a sensor or actuator that can directly communicate with a controller through the network. This differs from an ASC in that it typically deals only with one variable.
- AH. Extensible Markup Language (XML): A specification developed by the World Wide Web Consortium. XML is a pared-down version of SGML, designed especially for Web documents. It is a set of rules for encoding documents in machine-readable form that allows designers to create their own customized tags, enabling the definition, transmission, validation, and interpretation of data between applications and between organizations.

### 1.08 FUNCTIONAL INTENT

- A. Throughout Sections 23 09 50 through 23 09 55, the Sequences of Operation, and Section 23 09 59 detailed requirements are specified, some of which indicate a means, method or configuration acceptable to meet that requirement. Contractor may submit products that utilize alternate means, methods, and configurations that meet the functional intent. However these will only be allowed with prior approval.

### 1.09 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 .
- B. Electronic Submittals: While all requirements for hard copy submittal apply, control submittals and O&M information shall also be provided in electronic format as follows.
1. Drawings and Diagrams: Shop drawings shall be provided on electronic media as an AutoCAD (current version) and/or Adobe Portable Document Format file. All 'X reference' and font files must be provided with AutoCAD files.
  2. Other Submittals: All other submittals shall be provided in Adobe Portable Document Format (PDF).
- C. Qualifications: Manufacturer, Installer, and Key personnel qualifications as indicated for the appropriate item above.
- D. Product Data: Submit manufacturer's technical product data for each control device, panel, and accessory furnished, indicating dimensions, capacities, performance and electrical characteristics, and material finishes. Also include installation and start-up instructions.
- E. Shop Drawings: Submit shop drawings for each control system, including a complete drawing for each air handling unit, system, pump, device, etc. with all point descriptors, addresses and point names indicated. Each shop drawing shall contain the following information:
1. System Architecture and System Layout:
    - a. One-line diagram indicating schematic locations of all control units, workstations, LAN interface devices, gateways, etc. Indicate network number, device ID, , instance number, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the diagram.
    - b. Provide electronic floor plans locating all control units, workstations, LAN interface devices, gateways, etc. Include all network communication wiring routing, power wiring, power originating sources, and low voltage power wiring. Indicate network number, device ID, instance number, MAC address, drawing reference number, and controller type for each control unit. Indicate media, protocol, baud rate, and type of each LAN. All optical isolators, repeaters, end-of-line resistors, junctions, ground locations etc. shall be located on the floor plans. Wiring routing as-built conditions shall be maintained accurately throughout the construction period and the drawing shall be updated to accurately reflect accurate, actual installed conditions.
  2. Schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment and control devices. Include verbal description of sequence of operation.

3. All physical points on the schematic flow diagram shall be indicated with names, descriptors, and point addresses identified as listed in the point summary table.
  4. With each schematic, provide a point summary table listing building number and abbreviation, system type, equipment type, full point name, point description, Ethernet backbone network number, network number, device ID, object ID (object type, instance number). See Section 23 09 55 - Part III for additional requirements.
  5. Label each control device with setting or adjustable range of control.
  6. Label each input and output with the appropriate range.
  7. Provide a Bill of Materials with each schematic. Indicate device identification to match schematic and actual field labeling, quantity, actual product ordering number, manufacturer, description, size, voltage range, pressure range, temperature range, etc. as applicable.
  8. With each schematic, provide valve and actuator information including size, Cv, design flow, design pressure drop, manufacturer, model number, close off rating, etc. Indicate normal positions of spring return valves and dampers.
  9. Indicate all required electrical wiring. Electrical wiring diagrams shall include both ladder logic type diagram for motor starter, control, and safety circuits and detailed digital interface panel point termination diagrams with all wire numbers and terminal block numbers identified. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring, which are existing, factory-installed and portions to be field-installed.
  10. Details of control panels, including controls, instruments, and labeling shown in plan or elevation indicating the installed locations.
  11. Sheets shall be consecutively numbered.
  12. Each sheet shall have a title indicating the type of information included and the HVAC system controlled.
  13. Table of Contents listing sheet titles and sheet numbers.
  14. Legend and list of abbreviations.
  15. Memory allocation projections.
  16. Submit along with shop drawings but under separate cover calculated and guaranteed system response times of the most heavily loaded LAN in the system.
- F. Open Protocol Information
1. BACnet Systems:
    - a. BACnet object description, object ID, and device ID, for each I/O point.
    - b. Documentation for any non-standard BACnet objects, properties, or enumerations used detailing their structure, data types, and any associated lists of enumerated values.
    - c. Submit PICS indicating the BACnet functionality and configuration of each controller.
- G. Framed Control Drawings: Laminated control drawings including system control schematics, sequences of operation and panel termination drawings, shall be provided in panels for major pieces of equipment. Terminal unit drawings shall be located in the central plant equipment panel or mechanical room panel.
- H. Control Logic Documentation
1. Submit control logic program listings (for graphical programming) and logic flow charts (for line type programs) to document the control software of all control units.
  2. Control logic shall be annotated to describe how it accomplishes the sequence of operation. Annotations shall be sufficient to allow an operator to relate each program component (block or line) to corresponding portions of the specified Sequence of Operation.
  3. Include written description of each control sequence.
  4. Include control response, settings, setpoints, throttling ranges, gains, reset schedules, adjustable parameters and limits.
  5. Sheets shall be consecutively numbered.

6. Each sheet shall have a title indicating the controller designations and the HVAC system controlled.
  7. Include Table of Contents listing sheet titles and sheet numbers
  8. Submit one complete set of programming and operating manuals for all digital controllers concurrently with control logic documentation. This set will count toward the required number of Operation and Maintenance materials specified below and in Section 01 30 00.
- I. Operation and Maintenance Materials:
    1. Submit documents under provisions of Section 01 03 00. One copy of the materials shall be delivered directly to the State facilities operation staff, in addition to the copies required by other Sections.
    2. Submit maintenance instructions and spare parts lists for each type of control device, control unit, and accessory.
    3. Submit BAS User's Guides (Operating Manuals) for each controller type .
    4. Submit BAS advanced Programming Manuals for each controller type.
    5. Include all submittals (product data, shop drawings, control logic documentation, hardware manuals, software manuals, installation guides or manuals, maintenance instructions and spare parts lists) in maintenance manual; in accordance with requirements of Division 1.
  - J. Controls contractor shall provide the State with all product line technical manuals and technical bulletins, to include new and upgraded products, by the same distribution channel as to dealers or branches. This service will be provided for 5 years as part of the contract price, and will be offered to the State thereafter for the same price as to a dealer or branch.
  - K. Manufacturers Certificates: For all listed and/or labeled products, provide certificate of conformance.
  - L. Product Warranty Certificates: submit manufacturers product warranty certificates covering the hardware provided.

#### **1.10 PROJECT RECORD DOCUMENTS**

- A. Submit documents under provisions of Section 01 30 00.
- B. Record copies of product data and control shop drawings updated to reflect the final installed condition.
- C. Record copies of approved control logic programming and database on paper and on CD's. Accurately record actual setpoints and settings of controls, final sequence of operation, including changes to programs made after submission and approval of shop drawings and including changes to programs made during specified testing.
- D. Record copies of approved project specific graphic software on CDs.
- E. Record copies shall include individual floor plans with controller locations with all interconnecting wiring routing including space sensors, LAN wiring, power wiring, low voltage power wiring. Indicate device instance, MAC address and drawing reference number.
- F. Provide record riser diagram showing the location of all controllers.
- G. Maintain project record documents throughout the warranty period and submit final documents at the end of the warranty period

#### **1.11 SYSTEM ARCHITECTURE**

- A. The system provided shall incorporate hardware resources sufficient to meet the functional requirements of these Specifications. The Contractor shall include all items not specifically itemized in these Specifications that are necessary to implement, maintain, and operate the system in compliance with the functional intent of these Specifications.
- B. The system shall be configured as a distributed processing network(s) capable of expansion as specified below.

- C. The system architecture shall consist of the Ethernet-based State Network, and Controlling LANs that support BCs, AACs, ASCs, Operator Workstations (OWS), Smart Devices (SD), and Remote Communication Devices (RCDs) as applicable. The following indicates a functional description of the BAS structure.
1. State Network: Internet-based network connecting multiple facilities with a central data and application server, accessible via standard web-browser. This is an existing infrastructure and contractor is not required to configure any components of this network. Refer to Section 23 09 54 for requirements. This contractor shall integrate the controlling devices and the CCS together.
  2. Local Supervisory LAN: The Local Supervisory LAN shall be an Ethernet-based, 100 Mbps LAN connecting Primary Control LANs and OWSs. The LAN serves as the inter-BC gateway and OWS-to-BC gateway and communications path. Contractor shall provide this as a dedicated LAN for the control system. LAN shall be IEEE 802.3 Ethernet over Fiber or Category 5 cable with switches and routers that support 100 Mbps throughput. Power-line carrier communication shall not be acceptable for communications. The physical media will be that installed for the IT infrastructure of the facility and as such network drops will be provided under that scope of work to facilitate work of this scope. This network will be 100 Mbps and therefore all network interface cards shall support that speed. The higher level layers of this network shall be BACnet as described below:
    - a. BACnet Supervisory LAN: Shall be BACnet/IP as defined in the BACnet standard, and shall share a common network number for the Ethernet backbone, as defined in the BACnet standard. Point/Object naming conventions are specified in 23 09 55 - Part III.
  3. Controlling LAN: High-speed, peer-to-peer communicating LAN used to connect AACs, ASCs and Building Controllers (BCs) and communicate exclusively control information. Acceptable technologies include:
    - a. Ethernet (IEEE802.3)
    - b. ARCNET (IEEE802.4)
    - c. Communication to/from building controller (BC) and the control system server (CSS) shall utilize standard TCP/IP, BACnet/IP ports (80and/or 47808)
  4. Secondary Controlling LAN : Network used to connect AACs, ASCs or SDs. These can be Master Slave/ Token Passing or polling, in addition to those allowed for Primary Controller LANs. Network speed vs. the number of controllers on the LAN shall be dictated by the response time and trending requirements.
- D. Dynamic Data Access: Any data throughout any level of the network shall be available to and accessible by all other devices, Controllers and OWS, whether directly connected or connected remotely.
- E. Remote Data Access: The system shall support the following methods of remote access to the building data.
1. Browser-based access: A remote user using a standard browser shall be able to access all control system facilities and graphics with proper authentication. The State shall maintain continuous network connection. The following paradigms are acceptable for browser-based access:
    - a. Native Internet-based user interface (HTML, Java, XML, etc.) via a standard freely distributed web browser that does not require a Windows client software installation.
- F. The communication speed between the controllers, LAN interface devices, and operator interface devices shall be sufficient to ensure fast system response time under any loading condition. Contractor shall submit guaranteed response times with shop drawings including calculations to support the guarantee. In no case shall delay times between an event, request, or command initiation and its completion be greater than those listed herein. Contractor shall recommend reconfiguring the LAN as necessary to accomplish these performance requirements.:

1. 5 seconds between a Level 1 (critical) alarm occurrence and enunciation at operator workstation.
  2. 10 seconds between a Level 2 alarm occurrence and enunciation at operator workstation.
  3. 20 seconds between and a Level 3-5 alarm occurrence and enunciation at operator workstation.
  4. 10 seconds between an operator command via the operator interface to change a setpoint and the subsequent change in the controller.
  5. 5 seconds between an operator command via the operator interface to start/stop a device and the subsequent command to be received at the controller.
  6. 10 seconds between a change of value or state of an input and it being updated on the operator interface.
  7. 10 seconds between an operator selection of a graphic and it completely painting the screen and updating at least 10 points.
- G. Control Systems Server (CSS): A server class computer(s) that maintains the systems configuration and programming database. This server is located at the State of Delaware's data center in a virtual environment and serves as an access point to BAS. It shall hold the backup files of the information downloaded into the individual controllers and as such support uploading and downloading that information directly to/from the controllers. It shall also act as a control information server to non-control system based programs. It shall allow secure multiple-access to the control information. Refer to Section 23 09 52 - BAS Operator Interfaces for its requirements.
- H. The Operator Interface shall provide for overall system supervision, graphical user interface, management report generation, alarm annunciation, and remote monitoring. Refer to Section 23 09 52 - BAS Operator Interfaces.
- I. The BCs, AACs, ASCs, [and SDs] shall monitor, control, and provide the field interface for all points specified. Each BC, AAC, or ASC shall be capable of performing all specified energy management functions, and all DDC functions, independent of other BCs, AACs, or ASCs and operator interface devices as more fully specified in Section 23 09 53 - BAS Field Panels.
- J. Systems Configuration Database: The system architecture shall support maintaining the systems configuration database on the CSS. User tools provided to the State shall allow configuring, updating, maintaining, etc. current configurations and settings whether they are initiated at the server or the end device.
1. Database Schema shall be published and provided to the State to facilitate easy access to the data.
  2. Database shall be ODBC compliant.
- K. Interruptions or fault at any point on any Primary Controller LAN shall not interrupt communications between other nodes on the network. If a LAN is severed, two separate networks shall be formed and communications within each network shall continue uninterrupted.
- L. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.
- M. Anytime any controller's database or program is changed in the field, the controller shall be capable of automatically uploading the new data to the CSS.

### 1.12 WARRANTY MAINTENANCE

- A. Contractor shall warrant all products and labor for a period of (2) two years after Substantial Completion.
- B. The State reserves the right to make changes to the BAS during the warranty period. Such changes do not constitute a waiver of warranty. The Contractor shall warrant parts and installation work regardless of any such changes made by the State, unless the Contractor provides clear and convincing evidence that a specific problem is the result of such changes to the BAS.

- C. At no cost to the State, during the warranty period, the Contractor shall provide maintenance services for software and hardware components as specified below:
1. Maintenance services shall be provided for all devices and hardware specified in sections 23 09 51 through 23 09 59 . Service all equipment per the manufacturer's recommendations. All devices shall be calibrated within the last month of the warranty period.
  2. Emergency Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would result in property damage or loss of comfort control shall be corrected and repaired following notification by the State to the Contractor.
    - a. Response by telephone to any request for service shall be provided within two (2) hours of the State's initial telephone request for service.
    - b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the State's site within eight (8) hours of the State's initial telephone request for such services, as specified.
  3. Normal Service: Any malfunction, failure, or defect in any hardware component or failure of any control programming that would not result in property damage or loss of comfort control shall be corrected and repaired following telephonic notification by the State to the Contractor.
    - a. Response by telephone to any request for service shall be provided within eight (8) working hours (contractor specified 40 hr per week normal working period) of the State's initial telephone request for service.
    - b. In the event that the malfunction, failure, or defect is not corrected through the telephonic communication, at least one (1) hardware and software technician, trained in the system to be serviced, shall be dispatched to the State's site within three (3) working days of the State's initial telephone request for such services, as specified.
  4. Telephonic Request for Service: Contractor shall specify a maximum of three telephone numbers for The State to call in the event of a need for service. At least one of the lines shall be attended at any given time at all times. Alternatively, pagers can be used for technicians trained in system to be serviced. One of the three paged technicians shall respond to every call within 15 minutes.
  5. Technical Support: Contractor shall provide technical support by telephone throughout the warranty period.
  6. Preventive maintenance shall be provided throughout the warranty period in accordance with the hardware component manufacturer's requirements.

### **1.13 DELIVERY, STORAGE, AND HANDLING**

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons during shipping, storage and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather.

### **1.14 LISTING AND LABELING**

- A. The BAS and components shall be listed by Underwriters Laboratories (UL 916) as an Energy Management System.

## **PART 2 - PRODUCTS**

### **2.01 MANUFACTURERS (PRE-APPROVED BY THE STATE)**

- A. Johnson Controls by Modern Controls
- B. Substitutions: See Section 01 60 00 - Product Requirements

### **2.02 MATERIALS AND EQUIPMENT**

- A. Materials shall be new, the best of their respective kinds without imperfections or blemishes and shall not be damaged in any way. Used equipment shall not used in any way for the

permanent installation except where drawings or specs specifically allow existing materials to remain in place.

### **2.03 UNIFORMITY**

- A. To the extent practical, all equipment of the same type serving the same function shall be identical and from the same manufacturer.
- B. All new controllers installed on the control system network shall be furnished and installed by the BAS contractor.

## **PART 3 - EXECUTION**

### **3.01 INSPECTION**

- A. Examine areas and conditions under which control systems are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

### **3.02 INSTALLATION OF CONTROL SYSTEMS**

- A. General: Install systems and materials in accordance with manufacturer's instructions, roughing-in drawings and details shown on drawings.
- B. Network Connectivity: The BAS contractor shall provide two network connections with Cat-6 cables from the Building Controller to the State's IT network.
  - 1. The BAS contractor shall terminate one end of the two Cat-6 cables at or around the State's patch panel and make connections to the State's switch with green patch cables, following the instruction of the DFM's IT personnel.
  - 2. The BAS contractor shall terminate the other end of the two Cat-6 cables near or within the building controller cabinet with dual RJ-45 terminal box and make connection of one cable to the building controller. Note: the second connection is for on-site operator interface through a mobile computer. Exposed cable shall be protected by conduit or wire mold.
  - 3. The BAS contractor shall label the two network connections BAC-1 and BAC-2 on both ends.
- C. Refer to additional requirements in other sections of this specification.

### **3.03 SURGE PROTECTION**

- A. The Contractor shall furnish and install any power supply surge protection, filters, etc. as necessary for proper operation and protection of all BCs, AAC/ASCS operator interfaces, printers, routers, gateways and other hardware and interface devices. All equipment shall be capable of handling voltage variations 10% above or below measured nominal value, with no effect on hardware, software, communications, and data storage.

### **3.04 CONTROL POWER SOURCE AND SUPPLY**

- A. Section 23 09 50 Contractor shall extend all power source wiring required for operation of all equipment and devices provided under Sections 23 09 50 through 23 09 55 and Sequences of Operation.
- B. General requirements for obtaining power include the following:
  - 1. Obtain power from a source that feeds the equipment being controlled such that both the control component and the equipment are powered from the same panel. Where equipment is powered from a 460V source, obtain power from the electrically most proximate 120v source fed from a common origin.
  - 2. Where control equipment is located inside a new equipment enclosure, coordinate with the equipment manufacturer and feed the control with the same source as the equipment. If the equipment's control transformer is large enough and of the correct voltage to supply the controls it may be used. If the equipment's control transformer is not large enough or of the correct voltage to supply the controls provide separate transformer
  - 3. Where a controller controls multiple systems on varying levels of power reliability (normal, emergency, and/or interruptible), the controller shall be powered by the highest level of

reliability served. Furthermore, the controller in that condition shall monitor each power type served to determine so logic can assess whether a failure is due to a power loss and respond appropriately. A three-phase monitor into a digital input shall suffice as power monitoring.

4. Standalone Functionality: Refer to Section 23 09 53.

### **3.05 BAS STARTUP, COMMISSIONING AND TRAINING**

- A. Refer to Section 23 09 59

### **3.06 SEQUENCE OF OPERATION**

- A. Refer to Section 23 09 58 - Sequences of Operation

**END OF SECTION**

**SECTION 23 31 00**  
**HVAC DUCTS AND CASINGS**

**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Metal ductwork.
- B. Casing and plenums.
- C. Duct cleaning.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 07 13 - Duct Insulation: External insulation and duct liner.
- B. Section 23 33 00 - Air Duct Accessories.
- C. Section 23 37 00 - Air Outlets and Inlets.
- D. Section 23 05 93 - Testing, Adjusting, and Balancing for HVAC.

**1.03 REFERENCE STANDARDS**

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel; 2014.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process; 2017.
- C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2017.
- D. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements; 2015.
- E. ICC-ES AC106 - Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements; 2015.
- F. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements; 2015.
- G. ICC-ES AC308 - Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements; 2016.
- H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.
- I. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems; 2018.
- J. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations; 2017.
- K. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005 (Rev. 2009).
- L. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual; 2012, 2nd Edition.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Field Measurements: Contractor shall field measure existing conditions for use with duct shop drawings. The contractor shall measure and indicate location of existing building steel and other interferences on shop drawings.
- D. Shop Drawings: Contractor shall develop coordinated shop drawings from field measurements and design drawings. The coordinated shop drawings shall indicate duct fittings, particulars such as gages, sizes, welds, and configuration prior to start of work for Low pressure class and higher systems. Coordinated shop drawings shall also indicate existing and new piping.
- E. Test Reports: Indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA (LEAK).

- F. Project Record Documents: Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Show additional fittings used.

### 1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience, and approved by manufacturer.

### 1.06 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A, NFPA 90B, and NFPA 96 standards.

### 1.07 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.
- B. Maintain temperatures within acceptable range during and after installation of duct sealants.

## PART 2 PRODUCTS

### 2.01 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to NFPA 90A standards.
- B. All Ducts: Galvanized steel, or Manufactured Non-Metallic Ductwork.
- C. Low Pressure Supply (System with Cooling Coils): 1/2 inch w.g. pressure class, galvanized steel.
- D. Medium and High Pressure Supply: 1/2 inch w.g. pressure class, galvanized steel.
- E. Return and Relief: 1/2 inch w.g. pressure class, galvanized steel.
- F. General Exhaust: 1/2 inch w.g. pressure class, galvanized steel.

### 2.02 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
  1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
  2. VOC Content: Not more than 250 g/L, excluding water.
  3. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
  4. For Use With Flexible Ducts: UL labeled.
  5. Manufacturers:
    - a. Carlisle HVAC Products; Hardcast Iron-Grip 601 Water Based Duct Sealant: [www.carlislehvac.com/sle](http://www.carlislehvac.com/sle).
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
- C. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- D. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
  1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
  2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.
  3. Concrete Screw Type Anchors: Complying with ICC-ES AC193.
  4. Masonry Screw Type Anchors: Complying with ICC-ES AC106.
  5. Concrete Adhesive Type Anchors: Complying with ICC-ES AC308.

### 2.03 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.

- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- D. Provide turning vanes of perforated metal with glass fiber insulation when acoustical lining is indicated.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- F. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- G. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

#### 2.04 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufactured Non-Metallic Ductwork:
  - 1. Products:
    - a. Ductwork system materials including panels, adhesives, tapes, sealants, flanges and gaskets to be as a matched system listed by Underwriter's Laboratory to the UL-181 standard as a Class 1 air duct.
    - b. Duct air leakage rates to be in compliance with SMACNA Class 3 HVAC Duct Construction Standards, latest version per applicable leakage class based on pressure.
    - c. The panel shall be manufactured of CFC/HCFC-free rigid material thermobonded on both sides to a factory-applied .001"(25 micron) aluminum foil facing reinforced with a fiberglass scrim. The thermal conductivity shall be no greater than 0.13BTU in/hr x sq.ft x degree F(.018W/m x deg. C), and the density of the material shall not be less than 3.5 pcf(56 Kg/sq.m) with a minimum compressive strength of 28 psi (.2 MPa).
    - d. The standard thermal rating to be a minimum of an R-6.0 (1.2 RSI)
    - e. Installed ducting system must be warranted for a minimum of ten years from installation.
  - 2. Application:
    - a. All fabricated duct segment fittings shall be designed in accordance with SMACNA HVAC Duct Construction Standards, latest edition.
  - 3. Duct Installation:
    - a. All exterior mounted ductwork shall be protected against the elements with a non-duct penetrating weatherproof finish. Duct segments shall incorporate 6.0 mils thickness 5-ply aluminum, zero permeability, absolute vapor barrier self-adhesive jacketing. All external seams and joints shall be fully sealed with joint and seam tape during the installation process.
  - 4. Manufacturers:
    - a. KoolDuct; [www.ptmmanufacturing.com](http://www.ptmmanufacturing.com)
    - b. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
  - 1. UL labeled.
  - 2. Insulation: Fiberglass insulation with aluminized vapor barrier film.
  - 3. Pressure Rating: 4 inches WG positive and 1" inches WG negative.
  - 4. Maximum Velocity: 4000 fpm.
  - 5. Temperature Range: Minus 20 degrees F to 175 degrees F.
  - 6. Manufacturers:
    - a. Thermaflex Model M-KE.
    - b. Hart and Cooley Model F216.

- c. Substitutions: See Section 01 60 00 - Product Requirements.

## 2.05 CASINGS

- A. Fabricate casings in accordance with SMACNA (DCS) and construct for operating pressures indicated.
- B. Mount floor mounted casings on 4 inch high concrete curbs. At floor, rivet panels on 8 inch centers to angles. Where floors are acoustically insulated, provide liner of galvanized 18 gage, 0.0478 inch expanded metal mesh supported at 12 inch centers, turned up 12 inches at sides with sheet metal shields.
- C. Reinforce door frames with steel angles tied to horizontal and vertical plenum supporting angles. Install hinged access doors where indicated or required for access to equipment for cleaning and inspection.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. Install in accordance with manufacturer's instructions.
- C. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- D. Flexible Ducts: Connect to metal ducts with mechanical fastener, zip ties are not acceptable.
- E. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- F. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pilot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- G. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- H. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- I. Use double nuts and lock washers on threaded rod supports.
- J. Connect terminal units to supply ducts directly or with one foot maximum length of flexible duct. Do not use flexible duct to change direction.
- K. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

### 3.02 CLEANING

- A. Clean duct system and force air at high velocity through duct to remove accumulated dust. To obtain sufficient air, clean half the system at a time. Protect equipment that could be harmed by excessive dirt with temporary filters, or bypass during cleaning.

### 3.03 PRESSURE TESTING

- A. Prior to the balancing of the duct system by the AABC certified balancing contractor all ductwork shall be tested by the mechanical contractor for duct leakage in accordance with SMACNA Standards and AABC Standards Chapter 23. Duct leakage shall not exceed 1% for a duration of (10) ten minutes. Test pressures shall be as per SMACNA, however, not less than the following:
  - 1. Low Pressure Duct:
    - a. 25% above system operating pressure, but not less than 2" w.c. (500 Pa).
- B. Insulation materials shall not be applied until systems have been witnessed to meet the above testing requirements.
- C. The testing and balancing contractor shall witness and certify all duct pressure tests.

D. Additional leak testing requirements:

1. Disassemble, reassemble, and seal segments of duct systems to accommodate leakage testing and for compliance with test requirements.
2. If static pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
3. Provide seven (7) days advance notice for testing.

**3.04 SCHEDULES**

A. Ductwork Pressure Class:

1. Supply (Heating Systems): 2 inch (500 Pa)
2. Supply (System with Cooling Coils): 2 inch.
3. Return Ductwork: 1 inch.
4. General Exhaust: 1 inch.
5. Outside Air Intake: 1 inch.
6. Combustion Air: 1 inch (250 Pa)

**END OF SECTION**



**SECTION 23 36 00**  
**AIR TERMINAL UNITS****PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Fan-powered units.
- B. Variable volume terminal units.

**1.02 RELATED REQUIREMENTS**

- A. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- B. Section 23 21 13 - Hydronic Piping: Connections to heating coils.
- C. Section 23 21 14 - Hydronic Specialties: Connections to heating coils.
- D. Section 23 82 16 - Air Coils.
- E. Section 23 31 00 - HVAC Ducts and Casings.
- F. Section 23 33 00 - Air Duct Accessories.
- G. Section 23 82 00 - Convection Heating and Cooling Units: Air coils.

**1.03 REFERENCE STANDARDS**

- A. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils; 2001 (R2011).
- B. AHRI 880 (I-P) - Performance Rating of Air Terminals; 2011 with Addendum 1.
- C. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size; 2017.
- D. ASHRAE Std 130 - Methods of Testing Air Terminal Units; 2016.
- E. ASTM A492 - Standard Specification for Stainless Steel Rope Wire; 1995 (Reapproved 2013).
- F. ASTM A603 - Standard Specification for Zinc-Coated Steel Structural Wire Rope; 1998 (Reapproved 2014).
- G. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material); 2016.
- H. NFPA 70 - National Electrical Code; 2017.
- I. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems; 2018.
- J. SMACNA (SRM) - Seismic Restraint Manual Guidelines for Mechanical Systems; Sheet Metal and Air Conditioning Contractors' National Association; 2008.
- K. UL 181 - Standard for Factory-Made Air Ducts and Air Connectors; current edition, including all revisions.

**1.04 SUBMITTALS**

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings that indicate air flow, static pressure, and NC designation. Include electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate configuration, general assembly, and materials used in fabrication, and electrical characteristics and connection requirements.
  - 1. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of 1 to 4 inch wg.
- D. Manufacturer's Installation Instructions: Indicate support and hanging details, installation instructions, recommendations, and service clearances required.
- E. Project Record Documents: Record actual locations of units and locations of access doors required for access of valving.

- F. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists. Include directions for resetting constant-volume regulators.
- G. Warranty: Submit manufacturer warranty and ensure forms have been completed in State of Delaware OMB - Division of Facilities Management's name and registered with manufacturer.

**1.05 QUALITY ASSURANCE**

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

**1.06 WARRANTY**

- A. See Section 01 78 00 - Closeout Submittals, for additional warranty requirements.
- B. Provide five year manufacturer warranty for air terminal units.

**PART 2 PRODUCTS****2.01 SINGLE-DUCT, VARIABLE-VOLUME AND CONSTANT-VOLUME UNITS**

- A. General:
  - 1. Factory-assembled, AHRI 880 (I-P) rated and bearing the AHRI seal, air volume control terminal with damper assembly, flow sensor, externally mounted volume controller, duct collars, and all required features.
  - 2. Control box bearing identification, including but not necessarily limited to nominal cfm, maximum and minimum factory-set airflow limits, coil type and coil (right or left hand) connection, where applicable.
- B. Unit Casing:
  - 1. Minimum 22 gage, 0.0299 inch galvanized steel.
    - a. Assembled with longitudinal lock seam construction.
    - b. Casing leakage to meet ASHRAE Std 130.
  - 2. Air Inlet Collar: Provide round, suitable for standard flexible duct sizes.
  - 3. Unit Discharge: Rectangular, with slip-and-drive connections.
  - 4. Acceptable Liners:
    - a. 1/2 inch thick, coated, fibrous-glass complying with ASTM C1071.
      - 1) Secure with adhesive.
      - 2) Coat edges exposed to airstream with NFPA 90A approved sealant.
      - 3) Cover liner with non-porous foil.
    - b. Liner not to contain pentabrominated diphenyl ether (CAS #32534-81-9) or octabrominated diphenyl ether.
- C. Damper Assembly:
  - 1. Heavy-gage, galvanized steel or extruded aluminum construction with solid steel, nickel-plated shaft pivoting on HDPE, self-lubricating bearings.
  - 2. Provide integral position indicator or alternative method for indicating damper position over full range of 90 degrees.
  - 3. Incorporate low leak damper blades for tight airflow shutoff.
- D. Hot Water Heating Coil:
  - 1. Coil Casing: Minimum 22 gage, 0.0299 inch galvanized steel, factory-installed on terminal discharge with rectangular outlet, duct connection type.
    - a. Access Door: Gasketed and insulated located on bottom and downstream of coils.
  - 2. Coil Fins: Aluminum or aluminum plated fins, mechanically-bonded to seamless copper tubes.
  - 3. Coil leak tested to minimum 350 psig.

4. Base performance data on tests run in accordance with AHRI 410 and units to bear AHRI 410 label.
- E. Controls:
1. DDC (Direct-Digital Controls):
    - a. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
    - b. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.
      - 1) Occupied and unoccupied operating mode.
      - 2) Remote reset of temperature or CFM set points.
      - 3) Proportional, plus integral control of room temperature.
      - 4) Monitoring and adjusting with portable terminal.
    - c. Room Sensor:
      - 1) Compatible with temperature controls specified.
      - 2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
  2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
    - a. Signal accuracy: Plus/minus five percent throughout terminal operating range.
  3. Control Sequence:
    - a. Suitable for operation with duct pressures between 0.25 and 3.0 inch wg inlet static pressure.
    - b. Include factory-mounted and piped, 5-micron filter; and adjustable, velocity-resetting, high-limit control with amplifying relay.

## 2.02 FAN-POWERED SERIES UNITS

- A. General:
1. Factory-assembled and wired, AHRI 880 (I-P) rated, horizontal fan-powered terminal unit with blower, blower motor, mixing plenum, and primary air damper contained in a single unit housing.
- B. Unit Casing:
1. Minimum 22 gage, 0.0299 inch galvanized steel.
  2. Primary Air Inlet Collar: Suitable for standard flexible duct sizes.
  3. Unit Discharge: Rectangular, suitable for flanged duct connection.
  4. Plenum Inlet: Filter rack with disposable filters.
    - a. 1 inch thick disposable fiberglass filters.
    - b. Minimum Efficiency Reporting Value (MERV): 4, when tested in accordance with ASHRAE Std 52.2.
  5. Acceptable Liners:
    - a. 1/2 inch thick, coated, fibrous-glass complying with ASTM C1071.
      - 1) Secure with adhesive.
      - 2) Coat edges exposed to airstream with NFPA 90A approved sealant.
      - 3) Cover liner with non-porous foil.
- C. Primary Air Damper Assembly:
1. Heavy-gage, galvanized steel or extruded aluminum construction with solid shaft rotating in bearings.
  2. Provide indicator on damper shaft or alternative method for indicating damper position over full range of 90 degrees.
  3. Incorporate low leak (2 percent) damper blades for tight airflow shutoff.
  4. Fan(s): Forward curved, centrifugal type.
  5. Fan Motor:
    - a. PSC: Thermally protected, single speed, multi-voltage (120, 208/240, 277), 60 cycle, single phase, energy efficient design, permanently lubricated, using permanent split capacitor type for starting and specifically designed for use with a SCR (Silicon

- Controlled Rectifier) fan speed controller with three speed motors as an acceptable alternative.
- b. Fan motor shaft directly connected to fan and and isolated from unit casing to prevent transmission of vibration.
- D. Hot Water Heating Coil:
1. Coil Casing: Minimum 22 gage, 0.0299 inch galvanized steel, factory-installed on terminal unit with flanged discharge for attachment to downstream ductwork.
  2. Heavy-gage aluminum fins, mechanically bonded to tubes.
  3. Copper Tubes: 0.016 inch minimum wall thickness with male solder header connections.
  4. Coil leak tested to minimum 305 psig.
  5. Base performance data on tests run in accordance with AHRI 410.
- E. Electrical Requirements:
1. Single-point power connection.
  2. Equipment wiring to comply with requirements of NFPA 70.
- F. Controls:
1. DDC (Direct-Digital Controls):
    - a. Bi-directional Damper Actuator: 24 volt, powered closed, spring return open.
    - b. Microprocessor-Based Controller: Air volume controller, pressure-independent with electronic airflow transducers, factory-calibrated maximum and minimum CFM's.
      - 1) Occupied and unoccupied operating mode.
      - 2) Remote reset of temperature or CFM set points.
      - 3) Proportional, plus integral control of room temperature.
      - 4) Monitoring and adjusting with portable terminal.
    - c. Room Sensor:
      - 1) Compatible with temperature controls specified.
      - 2) Wall-mounted, system powered, with temperature set-point adjustment including connection access for portable operator terminal.
  2. Airflow Sensor: Differential pressure airflow device measuring total, static, and wake pressures.
    - a. Signal accuracy: Plus/minus five percent throughout terminal operating range.

**2.03 MANUFACTURERS**

- A. York/JCI
- B. Price Industries
- C. Metalaire
- D. Kruger
- E. Substitutions: See Section 01 60 00 - Product Requirements.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Install in accordance with manufacturer's instructions.
- B. Install the inlets of air terminal units and air flow sensors a minimum of four duct diameters from elbows, transitions, and duct takeoffs.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure with wire rope complying with ASTM A492 and ASTM A603 in accordance with SMACNA (SRM). See Section 23 05 48.
- E. Do not support from ductwork.
- F. Connect to ductwork in accordance with Section 23 31 00.
- G. Install heating coils in accordance with Section 23 82 00.

**3.02 ADJUSTING**

- A. Reset volume with damper operator attached to assembly allowing flow range modulation from 100 percent of design flow to zero percent full flow. Set units with heating coils for minimum 50 percent full flow.

**3.03 FIELD QUALITY CONTROL**

- A. See Section 01 40 00 - Quality Requirements, for additional requirements.

**3.04 CLEANING**

- A. Vacuum clean coils and inside of units.
- B. Install new filters.

**3.05 CLOSEOUT ACTIVITIES**

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.

**END OF SECTION**



**SECTION 23 52 16**  
**CONDENSING BOILERS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract apply to this Section, including General and Supplementary Conditions and Division 01 Specification Sections.

**1.02 SUMMARY**

- A. This Section includes packaged, factory-fabricated and -assembled, gas-fired, fire-tube condensing Boilers, trim and accessories for generating hot water.

**1.03 RELATED REQUIREMENTS**

- A. Section 03 3000 - Cast-in-Place Concrete.
- B. Section 23 2114 - Hydronic Specialties.
- C. Section 23 2214 - Steam and Condensate Heating Specialties.
- D. Section 23 5100 - Breechings, Chimneys, and Stacks.
- E. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections.

**1.04 REFERENCE STANDARDS**

- A. ANSI Z21.13 - American National Standard for Gas-Fired Low-Pressure Steam and Hot Water Boilers; 2012.
- B. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers; The American Society of Mechanical Engineers; 2013.
- C. NFPA 54 - National Fuel Gas Code; National Fire Protection Association; 2012.
- D. NFPA 58 - Liquefied Petroleum Gas Code; National Fire Protection Association; 2014.
- E. NFPA 70 - National Electrical Code; National Fire Protection Association; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

**1.05 SUBMITTALS**

- A. Product Data: Include performance data, operating characteristics, furnished specialties and accessories.
  - 1. Prior to flue vent installation, engineered calculations and drawings must be submitted to Engineer to thoroughly demonstrate that size and configuration conform to recommended size, length and footprint for each submitted Boiler.
- B. Efficiency Curves: At a minimum, submit efficiency curves for 100%, 50%, and 5% input firing rates at incoming water temperatures ranging from 60°F to 180°F. Test protocols shall conform to industry standards and shall be witnessed and reviewed by an independent, third-party group.
- C. Shop Drawings: For Boilers, Boiler trim and accessories, include:
  - 1. Plans, elevations, sections, details and attachments to other work
  - 2. Wiring Diagrams for power, signal and control wiring
- D. Source Quality Control Test Reports: Reports shall be included in submittals.
- E. Field Quality Control Test Reports: Reports shall be included in submittals.
- F. Operation and Maintenance Data: Data to be included in Boiler emergency, operation and maintenance manuals.
- G. Warranty: The complete heat exchanger assembly shall carry a ten (10) year limited warranty.
- H. Other Informational Submittals

1. The Boiler shall bear the ASME "H" stamp for 160 psi working pressure and shall be National Board listed.

### 1.06 QUALITY ASSURANCE

- A. Electrical Components, Devices and Accessories: Boilers must be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. I=B=R Performance Compliance: Condensing Boilers must be rated in accordance with applicable federal testing methods and verified by AHRI as capable of achieving the energy efficiency and performance ratings as tested within prescribed tolerances.
- C. ASME Compliance: Condensing Boilers must be constructed in accordance with ASME Boiler and Pressure Vessel Code, Section IV "Heating Boilers".
- D. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- E. DOE Compliance. Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- F. UL Compliance. Boilers must be tested for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

### 1.07 WARRANTY

- A. Standard Warranty: Boilers shall include manufacturer's standard form in which manufacturer agrees to repair or replace components of Boilers that fail in materials or workmanship within specified warranty period.
  1. Warranty Period for Fire-Tube Condensing Boilers
    - a. The pressure vessel/heat exchanger shall carry a 10-year from shipment, non-prorated, limited warranty against any failure due to condensate corrosion, thermal stress, mechanical defects or workmanship.
    - b. Manufacturer labeled control panels are conditionally warranted against failure for (2) two years from date of final acceptance.
    - c. All other components, with the exception of the igniter and flame detector, are conditionally guaranteed against any failure for 24 months from acceptance.

## PART 2 - PRODUCTS

### 2.01 MANUFACTURERS

- A. Basis-of-Design Product: Lockinvar KnightXL Series (KBN 400 - 800 MBH)
- B. Camus DynaForce Series (300 - 800 MBH)
- C. Raypak XFyre Series (H7 300 - 850 MBH)
- D. Thermal Solutions Apex Series (APX 399 - 800 MBH)
- E. Substitutions: See Section 01 60 00 - Product Requirements.

### 2.02 CONSTRUCTION

- A. Heat Exchanger: The heat exchanger shall be a fully welded 316L stainless steel, fire tube heat exchanger. The Fire Tube shall be welded to the tube sheets. The heat exchanger shall be designed for a single-pass water flow. There shall be no banding material, bolts, gaskets or "O" rings in the heat exchanger construction. The condensate collection basin shall be constructed of welded 316L stainless steel.
- B. Pressure Vessel: The Boiler water pressure drop shall not exceed than 2.4 psi at 180 gpm. The Boiler water connections shall be flanged 150-pound, ANSI rated. The pressure vessel shall be constructed of SA53 carbon steel, with a 0.25-inch thick wall and 0.50-inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV

pressure vessel code. The Boiler shall be designed so that the thermal efficiency increases as the Boiler firing rate decreases.

- C. The Boiler shall be constructed with a heavy gauge steel jacket assembly, primed and pre-painted on both sides. The combustion chamber shall be sealed and completely enclosed, independent of the outer jacket assembly, so that integrity of the outer jacket does not affect a proper seal. Two burner/flame observation ports shall be provided. The single burner shall be a premix design with an upper and a lower chamber supplied by individual combustion systems and constructed of high temperature stainless steel with a woven FeCrAlloy outer covering to provide modulating firing rates. The Boiler shall be supplied with two gas valves designed with negative pressure regulation and be equipped with a pulse width modulation blower system, to precisely control the fuel/air mixture to provide modulating Boiler firing rates for maximum efficiency. The Boiler shall operate in a safe condition with gas supply pressures as low as 4 inches of water column. The burner flame shall be ignited by direct spark ignition with flame monitoring via a flame sensor.
- D. The Boiler shall utilize a 24 VAC control circuit and components. The control system shall have a display for Boiler set-up, Boiler status, and Boiler diagnostics. All components shall be easily accessed and serviceable from the front and top of the jacket. The Boiler shall be equipped with a temperature/pressure gauge; high limit temperature control with manual reset; ASME certified pressure relief valve set for 50 psi (standard); outlet water temperature sensor (dual thermistor); return water temperature sensor; outdoor air sensor, flue temperature sensor (dual thermistor); high and low gas pressure switches, low water cut off with manual reset, blocked drain switch and a condensate trap for the heat exchanger condensate drain.
- E. Modulating Air/Fuel Valve and Burner: The Boiler burner shall be capable of a 5 to 1 turndown ratio of the firing rate without loss of combustion efficiency or staging of gas valves. The burner shall produce less than 20 ppm of NOx corrected to 3% excess oxygen.
- F. Ignition: Ignition shall be via regulated staged spark ignition with 100 percent main-valve shutoff and electronic flame supervision.

### 2.03 CONTROLS

- A. The Boiler shall be equipped with an 8" liquid crystal touch screen display, outdoor air reset, pump delay with freeze protection, pump exercise, ramp delay, and PC port connection. A secondary control that is field mounted outside or inside the appliance is not acceptable. The Boiler shall have alarm contacts for any failure, runtime contacts and data logging of runtime at given modulation rates, ignition attempts and ignition failures. The Boiler shall have a built-in "Cascade" to sequence and rotate while maintaining modulation of up to eight Boilers of different Btu inputs without utilization of an external controller. The internal "Cascade" function shall be capable of lead-lag, efficiency optimization, front-end loading, and rotation of lead Boiler every 24 hours. The control must be equipped with standard Modbus communication protocol with a minimum 55 readable points. The Boiler shall have a gateway device which will allow integration with BacNet (MSTP) protocols.
- B. This application shall utilize BacNet MSTP to communicate with the BAS system.
- C. The Boiler controller shall increase fan speed to boost flame signal when a weak flame signal is detected during normal operation.
- D. The Boiler shall be equipped with two terminal strips for electrical connection. A low voltage connection board with 30 data points for safety and operating controls, i.e., Alarm Contacts, Runtime Contacts, Tank Thermostat, System Supply Sensor, Outdoor Sensor, Tank Sensor, Modbus Building Management System signal and Cascade control circuit. A high voltage terminal strip shall be provided for Supply voltage. Supply voltage shall be 120 volt / 60 hertz / single phase on models up to 3,500,000 Btu's/Hr. The high voltage terminal strip plus integral relays are provided for independent pump control of the System pump, the Boiler pump and the Domestic Hot Water pump.

**2.04 ELECTRICAL POWER**

- A. Controllers, Electrical Devices and Wiring: Electrical devices and connections are specified in Division 26 sections.
- B. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the Boiler.
- C. Electrical Characteristics:
  - 1. Voltage: 120 V
  - 2. Phase: Single
  - 3. Frequency: 60 Hz
  - 4. Full-Load Current      16 Amps (Maximum)

**2.05 VENTING**

- A. Direct Vent system with horizontal sidewall termination of both the exhaust vent and combustion air. The flue shall be Category IV approved Stainless Steel sealed vent material terminating at the sidewall with the manufacturer's specified vent termination. A separate pipe shall supply combustion air directly to the boiler from the outside. The air inlet pipe must be sealed and may be other materials listed in the Installation manual. The boiler's total combined air intake length shall not exceed 100 equivalent feet. The boiler's total combined exhaust venting length shall not exceed 100 equivalent feet. The air inlet must terminate on the same sidewall as the exhaust.

**2.06 SOURCE QUALITY CONTROL**

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions and carbon monoxide in flue gas, and to achieve combustion efficiency. Perform hydrostatic testing.
- B. Test and inspect factory-assembled Boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.
  - 1. If Boilers are not factory assembled and fire-tested, the local vendor is responsible for all field assembly and testing.

**PART 3 - EXECUTION****3.01 EXAMINATION**

- A. Before Boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations. Examine piping and electrical connections to verify actual locations, sizes and other conditions affecting Boiler performance, maintenance and operations.
  - 1. Final Boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where Boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.02 BOILER INSTALLATION**

- A. Install Boilers level on concrete bases. Concrete materials and installation requirements are specified in Division 03, Section 03 30 00 Cast in Place Concrete.
- B. Install gas-fired Boilers according to NFPA 54.
- C. Assemble and install Boiler trim.
- D. Install electrical devices furnished with Boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

**3.03 CONNECTIONS**

- A. Piping installation requirements are specified in other Division 23 sections. Drawings indicate general arrangement of piping, fittings and specialties.

- B. Install piping adjacent to Boiler to permit service and maintenance.
- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.
- D. Connect gas piping to Boiler gas-train inlet with unions. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- E. Connect hot-water piping to supply and return Boiler tappings with shutoff valve and union or flange at each connection.
- F. Install piping from safety relief valves to nearest floor drain.
- G. Boiler Venting
  - 1. Install flue venting kit and combustion-air intake.
  - 2. Connect venting full size to Boiler connections. Comply with requirements in Division 23, Section 23 51 31 "Breechings, Chimneys and Stacks."
- H. Ground equipment according to Division 26, Section 26 05 26 "Grounding and Bonding for Electrical Systems."
- I. Connect wiring according to Division 26, Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables."

**3.04 DEMONSTRATION**

- A. The manufacturer or manufacturer's representative shall instruct the owner's personnel in the proper use, operation and maintenance of the equipment.
- B. The manufacturer or manufacturer's representative shall train the owner's personnel in normal procedures to be followed in case of an operation failure of equipment malfunction.
- C. 4 hours of on-site training shall be provided and coordinated to take place immediately after equipment start up.

**3.05 FIELD QUALITY CONTROL**

- A. Perform tests and inspections and prepare test reports.
  - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.
- B. Tests and Inspections
  - 1. Installation and Startup Test: Perform installation and startup checks according to manufacturer's written instructions.
  - 2. Leak Test: Perform hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - 4. Controls and Safeties: Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
    - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Remove and replace malfunctioning parts and retest as specified above.
- D. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.
- E. Performance Tests
  - 1. The Boiler manufacturer is expected to provide partial load thermal efficiency curves. These thermal efficiency curves must include at least three separate curves at various BTU input levels. If these curves are not available, it is the responsibility of the Boiler manufacturer to complete the following performance tests:

- a. Engage a factory-authorized service representative to inspect component assemblies and equipment installations, including connections, and to conduct performance testing.
- b. Boilers shall comply with performance requirements indicated, as determined by field performance tests. Adjust, modify, or replace equipment to comply.
- c. Repeat tests until results comply with requirements indicated.
- d. Provide analysis equipment required to determine performance.
- e. Provide temporary equipment and system modifications necessary to dissipate the heat produced during tests if building systems are not adequate.
- f. Notify Project Manager, Commissioner, and Engineer in advance of test dates.
- g. Document test results in a report and submit to Project Manager and Engineer.

**END OF SECTION**

**SECTION 23 74 10**  
**CUSTOM AIR HANDLING UNITS****PART 1 - GENERAL****1.01 RELATED DOCUMENTS**

- A. Drawings and general provisions of the contract, including general and supplementary conditions, and other Division 01 specification sections, apply to this section.

**1.02 SUMMARY**

- A. This section includes:
  - 1. Custom air handlers built on site.

**1.03 QUALITY ASSURANCE**

- A. NFPA Compliance: Units and components shall be designed, fabricated and installed in compliance NFPA 90A.
- B. UL Compliance: Electrical components used shall be listed and labeled by UL.
- C. NEMA Compliance: All motors shall comply with applicable NEMA standards.
- D. AMCA Compliance: All plenum fans shall bear the AMCA seal for sound and air performance. FC DWDI fans shall bear the AMCA seal for air performance.
- E. ARI Compliance: Coil shall be rated in accordance with ARI standard 410 and bear the ARI seal.
- F. AHRI Compliance: Air to air energy recovery components shall comply with AHRI 1060.
- G. ETL Compliance: Complete unit shall be listed and labeled by ETL per standards ANSI/UL 1995 and CAN/CSA C22.2 #236-05.

**1.04 SUBMITTALS**

- A. Product Data: Submit literature that indicates dimensions, weights, capacities, ratings, component performance, gauges and types of materials, electrical and control characteristics and connection requirements.
- B. Product Manufacturer's Rep must field measure and determine footprint.

**1.05 PRODUCT HANDLING**

- A. Deliver equipment to the job site with all exposed openings temporarily closed off with plywood, sheet metal or shrink-wrap. All equipment intended for indoor use must be shrink-wrapped prior to shipment.
- B. Product manufacturer shall provide experts to supervise the construction of this air handling unit on site.

**1.06 WARRANTY**

- A. General Warranty: Provide manufacturer's parts warranty on the entire unit and all components contained within for two (2) years. The warranty period begins at start up or six (6) months after shipment, whichever occurs first. The manufacturer must submit a written warranty agreeing to repair or replace components that fail in materials or workmanship within the specified warranty period. The warranty does not include parts associated with routine maintenance, such as belts, air filters, etc.
- B. Special Warranty: The manufacturer must submit a written warranty agreeing to repair or replace components that fail in materials or workmanship within the specified warranty period. The warranty does not include parts associated with routine maintenance, such as belts, air filters, etc.
  - 1. Five (5) year non-prorated parts warranty is provided for the compressors. The warranty period begins at start up or six (6) months after shipment, whichever occurs first.

**1.07 EXTRA MATERIALS**

- A. Furnish extra material described below that match the product installed, are packaged with protective covering for storage, and are identified on the shipping bill of lading:
  - 1. Filters: Furnish one (1) spare set of pre-filters for each pre-filter bank provided.

**PART 2 - PRODUCTS****2.01 MANUFACTURERS**

- A. Provide custom air handler, as manufactured by Innovent Air Handling Equipment (basis of design).
- B. Alternate manufacturers must be pre-approved and are subject to compliance with all the requirements listed in this specification.
- C. The manufacturer must have a minimum of 25 years of experience building custom air handling equipment.
- D. Project is based on the specified equipment. Any additional re-engineering or installation costs associated with using alternate manufacturer's equipment shall be borne by the installing contractor.

**2.02 CONSTRUCTION – STANDARD CASING (2" WALLS)**

- A. General: Construct unit as specified herein. Single wall construction is unacceptable and will be rejected. Frame and panel construction must be used with no individual panel exceeding 36" width. All panels on the unit must be fully removable without the use of cutting tools. All internal components must be removable without dismantling the structural framing of the unit. Unit shall be suitable for outdoor installation as detailed on the plan drawings.
- B. Base: Construct base of minimum .125" aluminum / 8 ga. stainless steel welded channel with cross supports and integral lifting lugs. Bolted bases are unacceptable. Removable lifting lugs are provided.
- C. Framing: Frame is constructed of a combination of galvanized and aluminum tube members designed to support flush-mounted double-wall panels. Vertical framing members must be easily removable, without the use of specialty tools or torches, for replacement of large internal components. Welded framing is not acceptable unless all internal components can be easily removed without cutting any welds. A closed-cell polyvinyl foam gasket with a thickness of 3/16" or greater must be applied between all framing members and panels.
- D. Flooring: Provide 2" double-wall, foam-injected floor construction. .072" 3003-H22 mill-finished aluminum tread plate floor provided over the foam-injected double wall floor. Outer floor panel shall be 22 ga. galvanized G90 steel. Floor panels shall be foam injected for optimal support strength and to eliminate "oil-canning". Floor panels shall be secured to the unit base frame with flush screws for a smooth walk-on surface and sealed with a cross-lined butyl rubber compound containing zero VOC's and meeting ASTM E-84. A minimum 1" lip must be provided around all floor penetrations. Walk-on grating must be provided over all accessible floor mounted duct connections.
- E. Panels: Unit shall have non-load bearing, fully-removable, heavy gauge 2" double-wall panels.
- F. Exterior Materials: Exterior skin shall be galvanized G60 steel or galvanealed steel for painted equipment. Unpainted galvanized exterior unacceptable if unit casing or framework is welded.
  - 1. A textured polyester paint (light gray color) shall be provided. Coating shall be salt spray tested per ASTM B117 for a minimum of 1,800 hours and have no blistering or red rust on the face when the testing is completed.
- G. Interior Materials: Interior skin shall be galvanized G90 steel.
  - 1. Perforated liner is provided in the fan sections for additional sound attenuation. The perforated liner is incorporated into the standard panel design providing a completely flush inner surface. The insulation behind the perforated metal must be non-porous, fiber-free

and include an EPA-registered antimicrobial agent for protection against mold, fungal and bacterial growth.

- H. Thermal break construction: The entire casing, excluding doors upstream of the cooling coil, must be built such that no member on the exterior of the unit, excluding fasteners, has through metal contact with any member on the interior of the unit, excluding fasteners.
- I. Casing Ratings: Maximum casing panel deflection shall not exceed L/250 at the design total static pressure (where L is the longest panel span on the unit). Casing shall meet a SMACNA duct leakage class (DLC) rating of 5.0 or better. The panel insertion loss, per octave band, shall not be less than the following:

<b>FREQUENCY (HZ):</b>	<b>100</b>	<b>125</b>	<b>250</b>	<b>500</b>	<b>1000</b>	<b>2000</b>	<b>4000</b>	<b>8000</b>		
<b>INSERTION LOSS (DB):</b>	<b>24</b>	<b>16</b>	<b>30</b>			<b>32</b>	<b>33</b>	<b>34</b>	<b>63</b>	<b>60</b>

- A. Insulation: All interior walls, floor, and ceiling shall be double wall and insulated with 2 lb/ft<sup>3</sup> polyurethane injected foam insulation having a minimum R-12 thermal value. No insulation shall be exposed to the air stream. Fiberglass or non-injected foam insulation is not acceptable and will be rejected.
- B. Access Doors: Provide double wall doors with the same thickness, insulation and inner/outer wall material as the rest of the air handler. Doors shall be full height (up to 72") with continuous stainless steel piano hinges extending the full distance of the door. Bi-directional compression latches with integral roller cam and hex-screw locking assembly must be provided. A 6061-T6 extruded aluminum frame with welded corners shall be provided around the full door perimeter. An EPDM bulb-type gasket must be provided in accordance with ASTM D 2000 (foam gasket tape or similar approach is not acceptable as a door seal method). Supply and exhaust air streams shall not be covered by a single door. Access panels in lieu of access door are unacceptable. Rain gutters are provided over all access doors that are not the full height of the unit casing. All doors that open with pressure shall be provided with a pressure relief safety latch. Provide doors for access to any area requiring routine maintenance.
- C. Door Accessories:
  - 1. Access doors shall be provided with 12"x12" double pane wire-glass windows in fan sections.
  - 2. Access doors shall be provided with aluminum door tie backs.
  - 3. Access doors shall be thermal break design downstream of cooling coil.
- D. Louvers: Provide 6063T5 extruded aluminum high performance drainable blade louvers with expanded aluminum bird screens over all exposed inlets and outlets. All louvers must be AMCA certified for water penetration and air performance.
- E. Roof: Provide roof with standing seam construction which allows removal of individual sections for inspection purposes without removal of the entire roof. A double wall foam injected panel must be provided below the roof liner creating 3 layers of metal between the conditioned air tunnel and ambient air. Pitch roof with sufficient slope to ensure water drainage. Units over 137" wide require double sloped roof designs. Roof overhang to be provided around complete perimeter of the unit. No penetrations can be made to the roof.

**2.03 BLOWER/MOTOR – DIRECT DRIVE**

- A. **Supply & Return blower: AF or BI blade direct drive plenum fans shall be provided. Fans shall be certified to bear the AMCA seal for air and sound performance. Fan motors must be selected to run at 60 Hz maximum at design conditions. Any fan/motor combination selected to run at a higher frequency will be rejected due to decreased motor life.**
- B. Motors shall be 3 phase TEFC with a NEMA frame, cast iron construction and a 1.15 service factor. Motor base shall be adjustable. Motor brake horsepower shall not exceed scheduled values. Fan brake horsepower shall not exceed 90% of motor horsepower. All motors shall be

premium efficiency with class F insulation. Shaft grounding kits will be provided on all VFD controlled motors.

- C. Isolation: Blower and motor shall be mounted on a unitary base with 1" housed seismic rated spring isolators.
- D. Accessories:
  - 1. Airflow probes shall be provided around the fan inlet cone. Probes shall be provided by the fan manufacturer to ensure accurate airflow measurement & zero resistance to airflow. All electronics and controls required to output airflow measurement are provided by the unit manufacturer / ATC contractor.

#### 2.04 DAMPERS

- A. Motorized dampers shall be low leakage type with aluminum construction, airfoil blades, vinyl edge seals, metal jamb seals, and synthetic bearings. Gravity dampers shall have aluminum frame, aluminum blades, extruded vinyl edge seals, and synthetic bearings.
- B. The following dampers shall be provided at a minimum (additional dampers may be required, please consult the sequence of operation to determine what is needed):
  - 1. Outside air control damper, modulating actuator.
  - 2. Recirculation air control damper, modulating actuator.
  - 3. Exhaust gravity damper.
  - 4. Supply air & return air smoke dampers, 2-position actuator (required if unit is greater than 15,000 CFM of supply air).
- C. A minimum outside air damper/flow monitor shall be provided equivalent to the Greenheck AMD-33. All electronics and controls for airflow measurement are provided by the ATC contractor.
- D. Airflow measurement probes shall be provided across the outside air hood for flow measurement. All electronics and controls for airflow measurement are provided by the ATC contractor.

#### 2.05 FILTERS

- A. **Return/Outside air filter: Provide 2" MERV 4 filter bank at the return air inlet. Mount in a galvanized steel side access slide rack and size for 500 fpm maximum face velocity. Filters must be rated per U.L. standard 900.**
- B. Filter Pressure Monitoring: Magnahelic pressure gauges shall be provided across all filter racks with a rain/sun shield provided on all outdoor mounted equipment. Filter differential pressure switches shall be provided across all filter racks.

#### 2.06 HEATING

- A. Hot water coil: Provide ARI rated coil constructed of 0.006" thick aluminum fins, 0.02" wall seamless copper tubes, and galvanized casing. An internal pipe chase shall be provided in the floor of the unit. Extend drain and vent connections to the unit exterior. Each coil is water immersion tested to 450 PSI prior to shipment.

#### 2.07 COOLING

- A. Integral water cooled refrigeration section: Provide integral water cooled system factory piped, wired, charged, and tested. Entire section must be assembled by the unit manufacturer. Mounting a different manufacturer's water cooled refrigeration section in the casing is not acceptable.
  - 1. Refer to the schedule for the minimum condensing section or unit EER requirements. Equipment with EER's less than what is scheduled will be rejected.
  - 2. Modulating head pressure control valves must be provided to keep system operational during low ambient conditions.

3. Provide hermetic scroll type compressors with suction and discharge schrader ports, mounted on RIS vibration isolators, reverse rotation protection, sight glass, oil level adjustment, filter drier and high/low pressure switches.
  - a. The compressors shall provide modulating control from 100% down to 10% of the full refrigeration system capacity. Staged control is not acceptable and will be rejected. Hot gas bypass is not an acceptable method of capacity control and will be rejected.
  - b. The compressors shall have modulating control using a VFD with a range of 90-30 Hz. Staged or digital control is not acceptable and will be rejected. Hot gas bypass is not an acceptable method of capacity control and will be rejected.

## 2.08 COOLING (AIR COOLED)

- A. DX coil: Provide ARI rated fully-interlaced coil with 0.016" thick seamless copper tubes, galvanized casing, and 0.006" thick aluminum fins. All refrigerant connections must remain inside the unit cabinet and run directly to the condensing section. Maximum face velocity is 500 FPM. Each coil is water immersion tested to 450 PSI prior to shipment
- B. Cooling coil drain pan: All cooling coils must be provided with stainless steel IAQ drain pans that begin at the entering air side of the coil face and extend a minimum of 12" past the leaving air side of the coil face. Entire underside of the drain pan, including the piping run to the casing exterior, must be coated with no less than 2" of spray foam insulation to ensure no sweating occurs below. Coil must sit on "walk-on" stainless steel supports spaced a maximum of 6" apart to allow full access to the coil face without damage to the drain pan. The drain pan must be sloped in a minimum of 2 directions to ensure proper drainage.

## 2.09 ELECTRICAL

- A. Wire units according to NEC and ETL list the entire unit. ETL listing of electrical panel only is unacceptable. All major electrical components shall be UL listed. Factory wire unit for single point power connection. Enclose all power wiring in conduit.
- B. **Provide fused disconnect with a short circuit rating (SCCR) of 65kA or more, fan motor starters/protectors, contactors, control transformer, control circuit fusing, service switch, and terminal block. Units supplied with VFDs shall have individual branch fusing per drive. A motor protector shall be provided if equipment manufacturer's manual bypass is required.**
- C. Provide NEMA 3R electrical/control panel.
- D. Factory test wiring and controls before shipment.
- E. A phase protection relay shall be provided for each unit. Upon sensing a loss of phase the unit shall be de-energized.
- F. A door safety kill switch shall be provided on all blower section access doors. The door safety kill switch shall de-energize the blower motor if the access door is opened. The kill switch shall prevent motor startup if the blower section access door is open.
- G. Dirty filter indicators: Provide differential pressure switches across all filter racks. Wire pressure switches to terminal block in main electrical panel.

## 2.10 DDC SYSTEM

- A. A refrigeration safety controller is included on any product containing compressors. The controller can be communicated to via the following inputs: Enable/disable command, heat/cool, cool/dehumidify, and a coil leaving temperature set point.
- B. The controller will communicate with the BAS through a Bacnet IP interface card provided by the equipment manufacturer. Points list necessary to control the equipment will be provided. Specific points can be provided upon request.
- C. All controls shall be provided by the ATC contractor to the equipment manufacturer for factory mounting and wiring.
- D. All controls shall be provided and installed in the field by the ATC contractor.

**PART 3 - EXECUTION****3.01 INSTALLATION**

- A. Install unit per manufacturer's recommendations and instructions as described in the Installation, Operation and Maintenance (IOM) manual.
- B. Contractor shall NOT use the units to provide temporary heating, cooling or ventilation to the building during construction.

**3.02 EXAMINATION**

- A. After completing the installation, inspect the air handler for damage, dirt or debris. Remove all dirt, construction debris and repair any damage to the finish including chips, scratches or dents.
- B. Replace the filters used during the construction phase.

**3.03 FIELD QUALITY CONTROL**

- A. After the equipment is installed, the manufacturer's representative shall inspect the installation and recommend any corrective actions. Do not startup the equipment until the following operations are completed:
  - 1. All controls are installed and fully operational.
  - 2. Power is connected to the unit.
  - 3. Shipping materials have been removed.
  - 4. Filtration media is installed and clean.
  - 5. Piping and duct connections are installed and operational.
  - 6. Leak checks are completed on all water connections.
  - 7. All wiring, refrigerant piping, gasketing and hardware are properly installed on any multiple section units.

**3.04 DEMONSTRATION**

- A. The manufacturer or manufacturer's representative shall instruct the owner's personnel in the proper use, operation and maintenance of the equipment.
- B. The manufacturer or manufacturer's representative shall train the owner's personnel in normal procedures to be followed in case of an operation failure or equipment malfunction.
- C. 4 hours of on-site training shall be provided and coordinated to take place immediately after equipment start up.

**END OF SECTION**

**DRAWINGS REDACTED**