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DELAWARE STATE POLICE FIRING RANGE
HVAC UPGRADE & ROOF REPLACEMENT
OMB/DFM CONTRACT # MJ1002000012 & MJ1002000008

ADDENDUM #4

CLARIFICATIONS:

- A. Provided drawing for clarification of installation and required slope of crickets.
- B. The numbering on the roofing drawings did not match the cover sheet. These drawing number have been revised.

QUESTIONS:

1. *Division 02 was not in the spec book we down loaded, did I miss it?*
 - a. This specification was issued as Addendum #2.
2. *Ref M102 and S100 Duct support tower right side, do we need a second support there to hold the top elbows, they are approx. 900#s each*
 - a. Structural plans are provided in Addendum #4 (this addendum) that describe this work.
3. *Ref M102 and S100 plan view, does each elbow needs a support, similar weight*
 - a. Structural plans are provided in Addendum #4 (this addendum) that describe this work.
4. *Ref M102 and S100 ERU Roof, the 98X98 duct will weigh approx. 3,000#s, please verify the ERU and duct as shown are self-supporting.*
 - a. Structural plans are provided in Addendum #4 (this addendum) that describe this work.
5. *Ref M103 detail4, can you provide a detail for fastening the duct supports to the concrete.*
 - a. Structural plans are provided in Addendum #4 (this addendum) that describe this work.
6. *Please provide a diffuser schedule with Manufacture and model number.*
 - a. Air Device Schedule is on drawing M601 and indicates the model numbers.
7. *Ref spec 23 21 13 item 2.03, what is the material for the Chilled underground?*
 - a. Section 23 21 13 has been updated with underground piping in Addendum #4 (this addendum).



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8. *Can you provide equipment cut sheets and weights for the existing roof top equipment to be demolished?*
- a. No, we do not have that information on hand.

DRAWING REVISIONS:

M-001: A suggested sequence of work was provided.

MD-101: Added scope for dismantling of targeting system and revised dimensions for asphalt replacement.

MD-202: Revised notes for patching roof.

M-101: Revised roof drainage direction and located electrical equipment.

M-201: Added flows to ERS diagram and miscellaneous valves to flow diagram.

M-202: Revised flows for pumps and equipment.

M-204: Added piping to ERU layout.

M-205: Added an ERS diagram.

M-402: Revised chilled water system controls diagram and sequence of operations.

M-403: Removed reference to the firing range damper and modified control sequence for AHU-3.

M-404: Revised ERU-1 controls diagram.

M-405: Revised F-3 controls diagram.

M-406: Added miscellaneous controls diagrams.

M-501: Revised underground piping detail and pump detail.

M-601: Revised air filter and unit heater schedules.

M-602: Revised HWP-1&2 and control valve schedule.

E-000: Added items to Electrical Legend.

E-100: Added Condensing Unit "CU/1". Changed circuit numbers of circuits serving chiller blanket heaters. Changed spare conduits from switchboard "SMDS". Changed identifier sheet numbers. Updated air compressor demolition notes. Changed and added keyed sheet notes (new work).

E-103: Deleted in-ground pull box.

E-200: Changed "ERU/1" enclosure power plans, panel schedules and keyed sheet notes.

E-201: New drawing – "ERU/1" enclosure lighting plan and luminaire schedule.



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E-300: Updated trenching, transformer pad and transformer grounding details with additional conduits. Changed trenching & ductbank detail.

E-301: Changed switchboard “SMDS” grounding detail and notes. Changed switchboard “SMDS” concrete foundation detail. Updated “ERU/1” enclosure grounding & bonding diagram.

E-400: Changed spare conduits from switchboard “SMDS”.

E-401: Changed spare conduits from switchboard “SMDS”.

S-100: Coordinated concrete pad.

S-101: Coordinated duct supports and concrete pad details.

S-102: Added details for piping supports and ERU-1 walkway.

S-103: Coordinated concrete pad and added independent testing requirements.

PRSI15155SPFR: Replace drawing in its entirety.

PRSI15155SPFR-2: Replace drawing in its entirety. Fixed numbering.

PRSI15155SPFR-3: Replace drawing in its entirety. Fixed numbering.

PRSI15155SPFR-4: Replace drawing in its entirety. Fixed numbering.

PRSI15155SPFR-5: Replace drawing in its entirety. Fixed numbering.\

- * Harvard Drawing # 20111-1 : Increase The removal and disposal amount of acoustical ceiling tiles and tracking system below the return ductwork area from 850 Sq. ft. to *1,400 Sq. ft.*
- * Harvard Drawing # 20111-1 : Change the removal and disposal from ‘Inclusive of Louvers, Grills and Dampers’ to *Inclusive of Louvers, Grills, Dampers, and Duct Hangers*
- * Harvard Drawing # 20111-1 : Change the HEPA vacuuming and Cleaning from ‘Targeting System, Top and Bottom Deflector Plates and Duct Hangers’ to just *Top and Bottom Deflector Plates. With a note that states that the Targeting system will be removed by others prior to ductwork demolition and a second note that states that remediation sub-contractor to responsible for lowering the top deflector plate to access the ductwork for demolition.*
- * **This drawing was not issued in this addendum but the information described above has been added to this project.**

SPECIFICATION REVISIONS:

00 41 13: Revised Bidform

00 78 00: Replace section in its entirety.

- * 01014 of Remediation Specifications: Delete line that reads ‘*Clean and Leave Duct Hangers for potential re-use by GC*’ listed on Part 1.6, Sub part B, item e on page 02 80 00 – 3. *Delete duct*



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hangers and running man target systems under component/ structure descriptions on Part 3 page 00 01 10 – 6 to. Increase Sq. ft. of ceiling tiles and tracking system from 850 Sq. ft. to 1,400 Sq. ft. under component/ structure descriptions on Part 3 page 00 01 10 – 6.

04 01 20: Replace section in its entirety.

07 50 29: Replace section in its entirety.

07 52 16: Replace section in its entirety.

07 72 53: New section “Method Specifications & Detail - Snow Guards”.

01 78 00: Additional closeout documentation added.

23 05 19: 3.02D Modified scale for static pressure and filter gauges.

* 23 09 59: 3.11C Shall now read “...*Provide services of controls contractor’s qualified technical personnel for two (2) 8-hour days...*”

23 21 13: 2.03 Added specifications for buried chilled water piping.

* 23 21 14: 2.03A 1. Spirotherm has been added as an approved manufacturer for In-line Air Separators.

23 51 00: 2.01 Added information.

* 23 64 12: 3.03A Shall now read “...*Manufacturer shall provide full parts and labor warranty coverage for a period of two years...*”

23 73 14: 2.07 Revised air filter section.

* **The specification section was not issued in this addendum but the information described above has been added to this project.**



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A. Addendum #4

1. Addendum #4 Summary (this document) (6 pages)
2. Firestone drawing (1 page).
3. Drawings (34 pages)
 - a. M-001
 - b. MD-101
 - c. MD-202
 - d. M-101
 - e. M-201
 - f. M-202
 - g. M-204
 - h. M-205
 - i. M-402
 - j. M-403
 - k. M-404
 - l. M-405
 - m. M-406
 - n. M-501
 - o. M-601
 - p. M-602
 - q. E-000
 - r. E-100
 - s. E-103
 - t. E-200
 - u. E-201
 - v. E-300
 - w. E-301
 - x. E-400
 - y. E-401
 - z. S-100
 - aa. S-101
 - bb. S-102
 - cc. S-103
 - dd. PRSI15155SPFR
 - ee. PRSI15155SPFR-2
 - ff. PRSI15155SPFR-3
 - gg. PRSI15155SPFR-4
 - hh. PRSI15155SPFR-5



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4. Specification (174 pages)

- a. 00 41 13
- b. 01 78 00
- c. 04 01 20
- d. 07 50 29
- e. 07 52 16
- f. 07 72 53
- g. 23 05 19
- h. 23 21 13
- i. 23 51 00
- j. 23 73 14

Summarized By: DEDC, LLC
John R. Farina, P.E.

Date: October 30, 2018

DRAWINGS REDACTED

ALTERNATES

Alternate prices conform to applicable project specification section. Refer to specifications for a complete description of the following Alternates. An "ADD" or "DEDUCT" amount is indicated by the crossed out part that does not apply.

ALTERNATE No. 1: All work to replace the air handling unit (MCC-1) located on the roof with AHU-3.

Add: _____
(\$ _____)

ALTERNATE No. 2: All work to install FC-1 in the classroom.

Add: _____
(\$ _____)

ALTERNATE No. 3: Installation of the specified mineral surface modified bitumen membrane roofing system on roof area #1. (Reference section 07 52 16 for information on Alternate #3). Add alternate includes removal of the existing roof system of the structural deck. Installation of the specified vapor barriers and base sheets. Installation of 5.2 inches of polyisocyanurate insulation and a 1/4" inch layer of Dens-Deck primer coverboard with a hot applied modified SBS mineral surface routing system. Alternate includes new flashing, metal and mechanical work.

Add: _____
(\$ _____)

ALTERNATE No. 4: Installation of the specified mineral surface modified bitumen membrane roofing system on roof area #2. (Reference section 07 52 16 for information on Alternate #4). Add alternate includes removal of the existing roof system to the structural deck. Installation of the specified vapor barriers and base sheets. Installation of 5.2 inches of polyisocyanurate insulation and a 1/4 inch layer of Dens-Deck Prime coverboard with a hot applied modified SBS mineral surfaced roofing system. Alternate includes new flashing, metal and mechanical work.

Add: _____
(\$ _____)

ALTERNATE No. 5: Caulking of vertical joints in concrete wall panels. (Reference section 04 01 20 for information on Alternate # 5). Add alternate includes raking out and recaulking of the existing vertical joints in the concrete wall panels around the perimeter of the building to the ground. Alternate includes each vertical joint for the entire length of the wall.

Add: _____
(\$ _____)

ALTERNATE No. 6A: Installation of an energy star rated coating system on roof areas 3 & 4. (Reference section 07 52 16 for information on alternate # 6A). Add alternate includes coating of the specified a hot applied modified SBS mineral surfaced roofing system with an EnergyStar rated coating system.

Add: _____
(\$ _____)

ALTERNATE No. 6B: Installation of an energy star rated coating system on roof areas 1. (Reference section 07 52 16 for information on alternate # 6B). Add alternate includes coating of the specified a hot applied modified SBS mineral surfaced roofing system with an EnergyStar rated coating system.

Add: _____
(\$ _____)

ALTERNATE No. 6C: Installation of an energy star rated coating system on roof area 2. (Reference section 07 52 16 for information on Alternate # 6C). Add alternate includes coating of the specified a hot applied modified SBS mineral surfaced roofing system with an EnergyStar rated coating system.

Add: _____
(\$ _____)

ALLOWANCE

Contractor shall include a \$36,000 ten thousand dollar allowance as part of the base bid for use upon the owner's instructions for any miscellaneous items found during construction.

Contractor shall include a \$14,000 fourteen thousand dollar allowance as part of the base bid for use upon the owner's instructions for the installation of the new transformer by the electrical utility during off hours.

HVAC UPGRADES & ROOF REPLACEMENT
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BID FORM

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for thirty (30) days from the date of opening of bids (60 days for School Districts and Department of Education), and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid.

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

Should I/We be awarded this contract, I/We pledge to achieve substantial completion of all the work within _____ calendar days of the Notice to Proceed.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

(State of Corporation)

Business Address: _____

Witness: _____ By: _____
(SEAL) (Authorized Signature)

(Title)

Date: _____

ATTACHMENTS

- Sub-Contractor List
- Non-Collusion Statement
- Affidavit(s) of Employee Drug Testing Program
- Bid Security
- (Others as Required by Project Manuals)

HVAC UPGRADES & ROOF REPLACEMENT
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BID FORM

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 6962 (d)(10)b Delaware Code, the following sub-contractor listing must accompany the bid submittal. The name and address of the sub-contractor **must be listed for each category** where the bidder intends to use a sub-contractor to perform that category of work. In order to provide full disclosure and acceptance of the bid by the *Owner*, **it is required that bidders list themselves as being the sub-contractor for all categories where he/she is qualified and intends to perform such work**. This form must be filled out completely with no additions or deletions.

<u>Subcontractor Category</u>	<u>Subcontractor</u>	<u>Address (City & State)</u>	<u>Subcontractors tax payer ID # or Delaware Business license #</u>
1. MECHANICAL	_____	_____	_____
2. ELECTRICAL	_____	_____	_____
3. CONCRETE	_____	_____	_____
4. CONTROLS	_____	_____	_____
5. SITE WORK	_____	_____	_____
6. ROOFING	_____	_____	_____
7. REMEDIATION	_____	_____	_____
8. MASONRY	_____	_____	_____

BID FORM
NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date to the Office of Management and Budget, Division of Facilities Management.

All the terms and conditions of OMB/DFM# MJ1002000012 & MJ1002000008 have been thoroughly examined and are understood.

NAME OF BIDDER: _____

**AUTHORIZED REPRESENTATIVE
(TYPED):** _____

**AUTHORIZED REPRESENTATIVE
(SIGNATURE):** _____

TITLE: _____

ADDRESS OF BIDDER: _____

E-MAIL: _____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

HVAC UPGRADES & ROOF REPLACEMENT
DELAWARE STATE POLICE FIRING RANGE
OMB/DFM CONTRACT NUMBERS MJ1002000012 & MJ1002000008

**AFFIDAVIT
OF
EMPLOYEE DRUG TESTING PROGRAM**

4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects requires that Contractors and Subcontractors implement a program of mandatory drug testing for Employees who work on Large Public Works Contracts funded all or in part with public funds.

We hereby certify that we have in place or will implement during the entire term of the contract a Mandatory Drug Testing Program for our employees on the jobsite that complies with this regulation:

Contractor/Subcontractor Name: _____

Contractor/Subcontractor Address: _____

Authorized Representative (typed or printed): _____

Authorized Representative (signature): _____

Title: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

HVAC UPGRADES & ROOF REPLACEMENT
DELAWARE STATE POLICE FIRING RANGE
OMB/DFM CONTRACT NUMBERS MJ1002000012 & MJ1002000008

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SECTION 01 78 00
CLOSEOUT SUBMITTALS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Project Record Documents.
- B. Operation and Maintenance Data.
- C. Warranties and bonds.

1.02 RELATED REQUIREMENTS

- A. Division 00 Documents
- B. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.
- C. Section 01 70 00 - Execution and Closeout Requirements: Contract closeout procedures.
- D. Individual Product Sections: Specific requirements for operation and maintenance data.
- E. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

- A. Project Record Documents: Submit documents to DEDC, LLC prior to final payment application.
- B. Operation and Maintenance Data:
 - 1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. DEDC, LLC will review draft and return one copy with comments.
 - 2. For equipment, or component parts of equipment put into service during construction and operated by State of Delaware OMB - Division of Facilities Management, submit completed documents within ten days after acceptance.
 - 3. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with DEDC, LLC comments. Revise content of all document sets as required prior to final submission.
 - 4. Submit two sets of revised final documents in final form within 10 days after final inspection.
- C. Warranties and Bonds:
 - 1. For equipment or component parts of equipment put into service during construction with State of Delaware OMB - Division of Facilities Management's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PROJECT RECORD DOCUMENTS

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 1. Drawings.
 - 2. Addenda.
 - 3. Change Orders and other modifications to the Contract.
 - 4. Manufacturer's instruction for assembly, installation, and adjusting.

- B. Ensure entries are complete and accurate, enabling future reference by State of Delaware OMB - Division of Facilities Management.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Record Drawings: Legibly mark each item to record actual construction including:
 - 1. Field changes of dimension and detail.
 - 2. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.
- D. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- E. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- F. Provide servicing and lubrication schedule, and list of lubricants required.
- G. Include manufacturer's printed operation and maintenance instructions.
- H. Include sequence of operation by controls manufacturer.
- I. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- J. Provide control diagrams by controls manufacturer as installed.
- K. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.
- L. Include test and balancing reports.
- M. Additional Requirements: As specified in individual product specification sections.

3.04 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data into durable manuals for State of Delaware OMB - Division of Facilities Management's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabbed divider for each system.
- C. Binders: Commercial quality, 8-1/2 by 11 inch three D side ring binders with durable plastic covers; 2 inch maximum ring size. When multiple binders are used, correlate data into related consistent groupings.
- D. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.
- E. Project Directory: Title and address of Project; names, addresses, and telephone numbers of DEDC, LLC, Consultants, Contractor and subcontractors, with names of responsible parties.
- F. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.
- G. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.
- H. Text: Manufacturer's printed data, or typewritten data on 24 pound paper.
- I. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.
- J. Arrangement of Contents: Organize each volume in parts as follows:
 - 1. Project Directory.
 - 2. Table of Contents, of all volumes, and of this volume.
 - 3. Operation and Maintenance Data: Arranged by system, then by product category.
 - a. Source data.
 - b. Operation and maintenance data.
 - c. Field quality control data.
 - d. Photocopies of warranties and bonds.

3.05 WARRANTIES AND BONDS

- A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with State of Delaware OMB - Division of Facilities Management's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Co-execute submittals when required.
- D. Retain warranties and bonds until time specified for submittal.

END OF SECTION

HVAC UPGRADES & ROOF REPLACEMENT
OMB/DFM CONTRACT NUMBERS
MJ1002000012 & MJ1002000008

DELAWARE STATE POLICE FIRING RANGE
OCTOBER 2018

CLOSEOUT SUBMITTALS
01 78 00-4

DEDC,LLC
16P008

**ALTERNATE # 5: SPECIFICATIONS – SECTION 040120
CAULKING VERTICAL JOINTS IN CONCRETE WALL PANELS**

1.0 GENERAL:

- A. The vertical joints in the concrete tilt-up wall panels will be raked out and recaulked.
- B. Caulk voids in concrete walls in the southwest and northeast corners of Roof Area 6.
- C. Rake out and re-caulk metal flashings on Roof Area 6.

2.0 CAULKING:

A. Masonry to Metal and Masonry to Masonry surfaces:

- 1. CAULKING - SIKA LM - 15. Sealant for Masonry to Metal and Masonry to Masonry surfaces:
 - a. Material will meet or exceed the enclosed performance specifications. Pre-approved sealant is Sikaflex - 15 LM.
 - 1. Sealant to be a low modulus, high performance, 1- component, polyurethane based, non-sag elastomeric sealant.
 - 2. Color of caulking will be selected by the State.
- 2. Location:
 - a. Vertical joints in concrete tilt-up wall panels.
 - b. Caulk voids in concrete walls in the southwest and northeast corners of Roof Area 6.
- 3. Surface Preparation:
 - a. Clean all surfaces, remove existing caulking.
 - b. All joints must be sound clean, dry, frost-free and free of oil and grease.
 - c. Curing compound residues and any other foreign matters must be thoroughly removed.

- d. Install backer material or joint filler, setting blocks, spacer shims and tapes as needed. Apply sealant in a continuous operation, using positive pressure adequate to properly fill and seal the joint.
- e. At the existing expansion and control joints; the joint will be thoroughly cleaned. Pack the joint to within one-half (1/2) inch of the surface with closed cell joint backing being inserted under 30% compression.
 - i. Tape both sides of joint.
 - ii. Prime, allow to dry.
 - iii. Caulk joints with Approved Sealant, color to match surrounding brick. Tool neatly into position.
 - iv. Remove tape.

4. Priming:

- a. Priming is not necessary.

5. Application:

- a. Recommended application temperatures at between 40 degrees F to 100 degrees F.
- b. For cold weather applications, pre-conditioning units to approximately 70 degrees F is recommended.
- c. Only apply sealant to clean, sound, dry and frost-free substrates.
- d. Sealant should be applied into joints when joint slot is mid-point of its designated expansion and contraction.
- e. Place nozzle of gun into bottom of the joint filing entire joint. Keep nozzle in the sealant, and continue on with a steady flow of sealant preceding the nozzle to avoid air entrapment.
- f. Avoid overlapping of sealant to eliminate entrapment of air.
- g. Tooling should be completed in one continuous stroke immediately after sealant application and before a skin forms. Tool or strike the sealant with light pressure to spread the material against the backer material and the joint surfaces. A tool with a concave profile is recommended to keep the sealant within the joint. Do not use liquid tooling aids such as water, soap or solvents.

- h. Joint dimension should allow for 1/4 inch minimum and 1/2 inch maximum thickness for sealant.
- i. Proper design is 2:1 width to depth ratio.
- 6. Masking:
 - a. Areas adjacent to joints should be masked to ensure neat sealant lines and to avoid contact with polished granites, metal or glass. Do not allow masking tape to touch clean surfaces on which the sealant is to adhere. Masking should be removed immediately after tooling.
- 7. Cleaning:
 - a. Immediately remove all excess sealant and smears adjacent to the joint with Xylol or Toluol as work progresses.
 - b. Cured material can only be removed mechanically.

B. Sealant for Glass to Metal and Metal to Metal surfaces:

- 1. Material will be Dow Corning 795 Building Sealant. Color to be selected by the State's Project Administrator.
 - a. Sealant to be one-part, neutral-cure, architectural-grade RTV silicone sealant that easily extrudes in any weather and cures quickly at room temperature.
- 2. Location:
 - a. The existing joints in the metal flashings.
- 3. Surface Preparation:
 - a. Clean all joints, removing all foreign matter and contaminants such as grease, oil, dust, water, frost, surface dirt, old sealants or glazing compounds and protective coatings.
- 4. Application:
 - a. Install backing material or joint filler, setting blocks, spaced shims and tapes as required.

- b. Mask areas adjacent to joints to ensure neat sealant lines.
- c. Primer is not generally required on non-porous surfaces. A test placement is recommended.
- d. Apply sealant in a continuous operation using positive pressure.
- e. Sealant can be applied using many types of air operated guns and most types of bulk dispensing equipment.
- f. Before a skin forms (typically with 15 minutes), toll the sealant with light pressure to spread the sealant against the backing material and joint surfaces.
- g. Remove masking tape as soon as the bead is tooled.

3.0 CLEAN-UP:

- A. Grounds around Building will be cleaned of all paper and debris. Cleaning must meet the satisfaction of the State's Project Administrator.
- B. Dumpster will be covered at the end of each days work. Area around dumpster will be cleaned on a daily basis.
- C. The finished coating system will be clean and free of any and all marks or spills. The final appearance of the painting project must be approved by the State's Administrator before the project is deemed complete.

**SPECIFICATIONS – SECTION 075029
METAL ROOF COATING – ROOF AREA 5:**

PART 1 — GENERAL

1.1 SECTION INCLUDES

- A. Restoration system over the properly prepared Metal Roof System on Roof Area 5.

1.2 REFERENCES

- A. National Roofing Contractors Association (NRCA):
 - 1. Roofing and Waterproofing Manual.

1.3 SYSTEM DESCRIPTION

- A. This section includes surface preparation and field painting of Roof Area 5.

Exposed exterior items and surfaces of **all** the existing standing seam metal roof panels, flashings, gutters, downspouts, edge metal etc.

- 1. Surface preparation, priming, and finish coats are specified in this Section.

1.4 SUBMITTALS

- A. Product Data: For each paint system specified, including primers.
 - 1. Material List: Provide an inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and coating material proposed for use.
 - 2. Manufacturer's Information: Provide manufacturer's technical information, including label analysis and instructions for handling, storing and applying each coating material proposed for use.
 - 3. Certification by the manufacturer that products supplied comply with local regulations controlling use of volatile organic compounds (VOC's).
- B. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for each type of finish-coat material indicated.

1. After color selection, the Contractor will furnish color samples for surfaces to be coated.

1.5 QUALIFICATIONS

- A. Applicator Qualifications: Engage an experienced applicator who has completed painting system applications similar in material and extent to that indicated for this Project with a record of successful in-service performance exceeding 10,000 S/F of roof panels that are at a minimum of 10 feet high and have a minimum slope 3” rise per foot, to be submitted with proposal along with address and contact information for verification by the owner.
- B. Mock-up for Field Samples: Prepare Mock-ups or Field Samples for Owner’s review and to establish requirements for rating and finish texture and insuring proper adhesion.
 1. Correct areas, modify method of application/installation, or adjust finish as directed by the paint system manufacturer to comply with specified requirements.
 2. Maintain mock-ups and field samples accessible to serve as a standard of quality for this Section.
 3. Sample shall consist of the following:
 - a. On roof surfaces and other exterior and interior components, duplicate finishes of prepared samples. Provide full-coat finish samples on at least 100 square feet of surface until required sheen, color, and texture are obtained; simulate finished lighting conditions for review of in-place work.
 - b. Provide full-coat finish samples for paint/coating systems.
 - c. Cost of the mock-ups shall be included in the contractor's bid.
- C. Source Limitations: Obtain primers and undercoat materials for each coating system from the same manufacturer as the finish coats.
- D. Installer's Field Supervision: Maintain a full-time Supervisor/Foreman on job site during all phases of work and at any time roofing work is in progress. Maintain proper supervision of workmen. Maintain a copy of the specifications in the possession of the Supervisor/Foremen and on the roof at all times.

- E. Insurance Certification: Assist Owner in preparation and submittal of roof installation acceptance certification as may be necessary in connection with fire and extended coverage insurance on roofing and associated work.

1.6 PRE-RESTORATION CONFERENCE

- A. Pre-Restoration Conference: Convene a pre-restoration conference approximately two (2) weeks before scheduled commencement of restoration system application and associated work.
- B. Require attendance of installer, paint system manufacturer's representative, and other representatives directly concerned with performance of the Work, including (where applicable) Owner's insurers, testing agencies and governing authorities.
- C. Objectives of conference to include:
 - 1. Review foreseeable methods and procedures related to painting work.
 - 2. Tour representative areas of painting substrates to inspect and discuss substrate conditions.
 - 3. Review painting system requirements (drawings, specifications and other contract documents).
 - 4. Review required submittals both completed and yet to be completed.
 - 5. Review and finalize construction schedule related to painting work and verify availability of materials, installer's personnel, equipment and facilities needed to make progress and avoid delays.
 - 6. Review required inspection, testing, certifying and material usage accounting procedures.
 - 7. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.
 - 8. Record discussion of conference including decisions and agreements (or disagreements) reached and furnish copy of record to each party attending. If substantial disagreements exist at conclusion of conference, determine how disagreements will be resolved and set date for reconvening conference.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site with seals and labels intact, in manufacturer's original containers, dry and undamaged.
- B. Store and handle containers in a dry, well-ventilated, weather-tight place to ensure no possibility of significant moisture exposure.
- C. Do not leave unused materials on the roof overnight or when painting work is not in progress unless protected from weather and other moisture sources.
 - 1. Protect from freezing. Keep storage area neat and orderly. Remove waste daily. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing and application.
- D. It is the responsibility of the contractor to secure all material and equipment on the job site. If any material or equipment is stored on the roof, the contractor must make sure that the integrity of the roof is not compromised at any time. Damage to the roof caused by the contractor will be the sole responsibility of the contractor and will be repaired or replaced at his expense.

1.8 SUPPLIER'S QUALITY CONTROL INSPECTIONS

- A. When the project is in progress, the restoration system supplier will provide the following:
 - 1. Keep the Owner informed as to the progress and quality of the work as observed.
 - 2. Provide job site inspections a minimum of three days a week.
 - 3. Report to the Owner in writing any failure or refusal of the Contractor to correct unacceptable practices called to the Contractor's attention.
 - 4. Confirm after completion that manufacturer has observed no applications procedures in conflict with the specifications other than those that may have been previously reported and corrected.

1.9 PROJECT CONDITIONS

- A. Weather Condition Limitations: Do not apply painting system during inclement weather or when a 30% chance of precipitation or greater is expected.

- B. Proceed with painting work only when existing and forecasted weather conditions will permit unit of work to be installed in accordance with manufacturer's recommendations and warranty requirements.
- C. Materials shall be stored at room temperature until immediately prior to application. Discontinue the application if the material cannot be stored at a temperature, which permits even distribution during application.
- D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during same day.
- E. When applying materials with spray equipment, take precautions to prevent over spray and/or solvents from damaging or defacing surrounding walls, building surfaces, vehicles or other property. Care should be taken to do the following:
 - 1. Close air intakes into the building.
 - 2. Have a dry chemical fire extinguisher available at the jobsite.
 - 3. Post and enforce "No Smoking" signs.
- F. Avoid inhaling spray mist; take precautions to ensure adequate ventilation.
- G. Protect completed roof sections from foot traffic for a period of at least 24-48 hours at 75° F and 50% relative humidity or until fully cured.
- H. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are between 50 and 90 degrees F (10 and 32 degrees C).

1.10 WARRANTY

- A. Upon completion of installation, and acceptance by the Owner, the manufacturer will supply to the Owner the appropriate warranty.
- B. Installer will submit a minimum of a ten (10) year warranty to the manufacturer with a copy directly to Owner.

1.11 PRODUCT OPTIONS AND SUBSTITUTIONS

- A. Any material submitted as an equal to the specified material must include a list of three (3) projects where the proposed material has been used on a similar roofing system as that which is specified and is located within a one hundred mile radius from the location of the project. In addition, the three projects must be at least three (3) years old and be available for inspection by the Owner or Owner's Representative.
- B. Any deficiencies in performance, warranty terms or improper submittal procedure will constitute grounds for immediate rejection of substitution.
- C. Substitution requests must have a letter from an alternate manufacturer stating specifically that inspections will be performed as mentioned in Section 1.8 above.
- D. Any material substitutions must be submitted a minimum of 10 days prior to the bid due date. Any accepted material substitutions will be accepted only by a formal addendum and thus allow all bidders an equal opportunity to bid on approved material alternates.

PART 2 — PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. When a particular trade name or performance standard is specified it shall be indicative of a minimum standard requirement.
- B. Provide products and inspection services as supplied by the pre-approved manufacturer.
- C. The Owner shall be the sole judge as to whether or not an item submitted as a substitute is truly equal.
- D. Pre-approved Materials:
 - I. Garland:
 - 1. Metal Roof Restoration Coating:
 - a. Primer – PPG Corafalon Epoxy Primer 572/574.
 - b. Finish Coat – PPG Corafalon ADS.
 - c. Clear Coat – PPG Corafalon ADS
 - II. Tremco:
 - 1. Metal Roof Restoration Coating – 5200 System by Rustoleum.

2.2 DESCRIPTION

- A. Material Compatibility: Provide primers, under-coaters, and finish-coat materials that are compatible with one another and the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best-quality "professional" paint material of the various coating types specified. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products names are required to be used to the exclusion of equivalent products of other manufacturers. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
- C. Colors: Provide color matches indicated by reference to manufacturer's color designations.

PART 3 — EXECUTION

3.1 EXAMINATION

- A. Examine substrate surfaces to receive coating and associated work and conditions under which roofing restoration will be performed. Do not proceed with painting until unsatisfactory conditions have been corrected in a manner acceptable to Manufacturer's Representative.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Cooperate with manufacturer, inspection and test agencies engaged or required to perform services in connection with installing the paint system.
- B. Insurance/Code Compliance: Where required by code, install and test the painting system to comply with governing regulation and specified insurance requirements.
- C. Protect other work from spillage of painting materials and prevent materials from entering or clogging drains and conductors.

3.3 CLEANING AND SURFACE PREPARATION FOR METAL RESTORATION

A. Exterior – Factory/Field Coated Metal Roof Panels (PVDF)

Surface preparation: Solvent clean, per SSPC-1, to remove any loose coating and any contamination that may be present. This may include removal of chlorides with Chlor-Rid solution and suitable high pressure washers. The substrate should be cleaned several times in the days before abrading substrate operations begin.

Before abrading substrate, surface should have less than 35 µg/cm² chloride contaminants, soluble ferrous ion levels, and sulfate contaminants, as verified by field or laboratory analysis using reliable, reproducible test equipment. If ppm is out specification, re-wash surface as mentioned above.

Abrade substrate, similar SSPC-SP-2 or SP-3, to obtain surface profile no greater than 1.0 mil, removing all field applied coatings, sheen, and corrosion. This can be accomplished with 120 grit sandpaper, or as contractor sees fit.

Surface should have less than 35 µg/cm² chloride contaminants, soluble ferrous ion levels, and sulfate contaminants, as verified by field or laboratory analysis using reliable, reproducible test equipment.

Existing caulk, sealant, and residue/contamination to be completely removed from substrate to be coated by means deemed appropriate by contractor.

Prior to coating, solvent wipe of “tack” off substrate to remove dust and residual contamination.

Before each coating operation (prime coat, intermediate coat, finish coat, and clear coat), surface should have less than 35 µg/cm² Chloride contaminants, soluble ferrous ion levels, and sulfate contaminants, as verified by field or laboratory analysis using reliable, reproducible test equipment. If ppm is out specification, re-wash surface as mentioned above.

Spot Prime Bare galvanized or corroded areas – to be supplied by manufacturer.

Apply one coat of PPG Coraflon Epoxy Primer 572/574 @ average 2.0-2.5 mils DFT.

Prime Coat – to be supplied by the manufacturer.

Apply one coat of PPG Coraflon ADS Epoxy Primer 572/574 @ 2.0-2.5 mils DFT

Allow to dry for 5 hours before applying finish coat, and a maximum of 3 days.

10 Year Warranty as provided by the manufacturer.

Finish Coat – to be supplied by the manufacturer.

Apply one coat of PPG Coraflon ADS @ 1.5-2.0 mils DFT.

Color to be selected by the State.

Clear Coat – to be supplied by the manufacturer.
Apply one coat of PPG Coraflon ADS @ 1.5-2.0 mils DFT

3.4 RESTORATION PRODUCT APPLICATION PRE-TREATMENTS

- A. Known Growth - General Surfaces: Once areas of moss, mold, algae and other fungal growths or vegetation have been removed and surfaces have also been thoroughly cleaned, apply a biocidal wash at a maximum spread rate of 0.2 gallons/square, to guard against subsequent infection. Allow to dry onto absorbent surfaces before continuing with the application. On non-absorbent surfaces, allow to react before thoroughly rinsing to remove all traces of the solution. Note: See Health & Safety data before use.

3.5 PRIMING

- A. Rust must be removed by the most rigorous method suitable for the particular project. Consult the manufacturers representative for complete information on treatment of rusted metal.

3.6 SYSTEM APPLICATION- ON SEAMS, FLASHINGS, DETAILS AND FIELD

- A. Fasteners
 - 1. Make sure all fasteners are properly tightened and neoprene washers are in place. Tighten all loose fasteners or replace with oversize fasteners as necessary. Missing fasteners must be replaced.
 - 2. Create a watertight seal on all fastener heads by applying a heavy dab of approved sealant to the tops of all fastener heads.
 - 3. Fasteners shall be stainless steel. Coating shall be applied in strict accordance with manufacture's published directions and instructions.**3.9 CAULKING /**

SEALANTS

- A. All coating / substrate and window / substrate interfaces shall be caulked / sealed with Dow 795 Sealant, or equal, per manufacturer's recommendations.
- B. The caulking / sealant application is to follow the primer & topcoat applications, with all caulking / sealant applied to final coated substrate.

3.10 FIELD QUALITY CONTROL

- A. Require attendance of materials supplier's representatives at site during installation of the painting system.
- B. Correct defects or irregularities discovered during field inspection.
- C. Contractor is required to strictly adhere to the coating manufacturer's recommended practices with regard to:

- Storage
- Mixing / Thinning
- Application
- Environmental Conditions / Concerns

- D. Contractor is required to strictly adhere to the caulking / sealant manufacturer's practices with regard to application

- E. Contractor accepts all responsibility and liability for:

- Public safety / worker safety
- Hazardous & non-hazardous waste disposal
- Airborne paint and overspray concerns & claims
- All masking and protection of glass and non-coated substrate
- Any and all damage to glass and substrates.
- Compliance with all applicable codes, standards, and regulations

- F. Owner reserves the right to engage in independent 3rd party inspection for all work in progress. Inspection of the following areas should be considered appropriate:

Surface preparation: determine that the degree of surface preparation specified is achieved. Surface profile to be measured using coarse Testex Tape/micrometer. No visible contamination has occurred since the surface prep operation, or since application of previous coat. There are no visible defects in previous coat.

Coating storage: Determine that all coatings are stored within the manufacturer's recommended storage temperatures. Establish that the coatings to be applied have not been damaged by age, improper storage, handling, etc. Establish that the coatings to be applied are the coatings specified.

Mixing and thinning: Document all product codes and batch numbers. Determine that the proper mixing ratios, components, induction times, and thinner amounts & product codes are correct.

Application: Document application equipment including tip sizes, pressures, and relevant information. Measure coating DFT thickness per SSPC PA-2, monitor and record

applicator's WFT measurements if possible. Observe and document all pinholes, runs, sags, holidays, dry-spray, and visible defects in applied coating.

Environmental: Document ambient temperatures, relative humidity, surface temperature, and dew point prior to application. Establish that each reading is within the manufacturer's specified range prior to application.

- G. The Manufacturer, and PPG Industries, Inc. reserves the right to conduct periodic inspections of the surface preparation, coating, and caulking operations as necessary. The periodic inspections are not to interfere with the normal daily work sequence, contractor cooperation and use of rigging may be required.
- H. The Manufacturer may require a mock-up application of the complete surface preparation / coating system to an area approximately 100 square feet and agreed upon by all parties to simulate finished product for owner's approval.
- I. The Manufacturer reserves the right to notify the owner or owner's representative if the contractor fails to meet any portion of the specification.

3.11 FINAL INSPECTION

- A. At completion of roofing installation and associated work, meet with Contractor, Owner, and painting system supplier's representative and other representatives directly concerned with performance of painting system.
- B. Walk roof surface areas of the building, inspect perimeter building edges as well as flashing of roof penetrations, walls, curbs and other equipment. List all items requiring correction or completion and furnish copy of list to each party in attendance.C. Repair or replace deteriorated or defective work found at time above inspection as required to produce an installation which is free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- D. Following the final inspection, provide written notice of acceptance of the installation from the restoration system supplier.
- E. Project quality control documentation: The restoration material supplier shall provide the owner with a project manual that contains all written photographic reports produced during the material installation as specified above.

END OF SECTION

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SPECIFICATIONS – DOCUMENT 075216
STATE OF DELAWARE OFFICE OF MANAGEMENT AND BUDGET, DELAWARE
STATE POLICE INDOOR RANGE ROOF REPLACEMENT PROJECT:
GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.
- B. Roof System: The Contractor will use the system described under Part 2 product section insure the physical characteristics of the submitted product meet the requirements of the specification. Materials will be either the materials used in the specification of equal materials that will meet or exceed the values listed in the Materials Specification section of this document.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Roof Removal.
 - 2. Vapor Barriers over all structural decks.
 - 3. Double layer of roof insulation on all structural decks
 - 4. Two plies of Type VI Glass felt, one ply of 158 mil mineral surfaced modified membrane.
 - 5. Double Layer of Roofing insulation.
 - 6. Roof membrane surfacing material.
 - 7. Roof flashings and counter flashings.
 - 8. Walkways.
 - 9. Interior Drains.
 - 10. Edge Metal

1.3 DEFINITIONS

- A. Roofing Terminology: Refer to ASTM D 1079 for definitions of terms related to roofing work not otherwise defined in this Section.
- B. Hot Roofing Asphalt: Roofing asphalt heated to its equiviscous temperature, the temperature at which its viscosity is 125 centipoise for mop-applied roofing asphalt and 75 centipoise for mechanical spreader-applied roofing asphalt within a

range of plus or minus 25 deg F (14 deg C) measured at the mop cart or mechanical spreader immediately before application.

1.4 PERFORMANCE REQUIREMENTS

- A. General: Install a watertight, modified bituminous membrane roofing and base flashing system with compatible components that will not permit the passage of liquid water and will withstand wind loads, thermally induced movement, and exposure to weather without failure.
 - 1. Roofing system shall comply with the following:
 - a. 65 mile per hour wind speed warranty.
 - b. Class A fire rating

1.5 SUBMITTALS

- A. Product Data: For each type of roofing product specified. Include data substantiating that materials comply with requirements.
- B. Shop Drawings: Include plans, sections, details, and attachments to other work, for the following:
 - 1. Base flashings, cants, and membrane terminations.
 - 2. Flat and Tapered insulation, including slopes.
 - 3. Crickets, saddles, and tapered edge strips, including slopes.
- C. Samples for Verification: Of the following products:
 - 1. 12-by-12-inch (300-by-300-mm) square of modified bituminous, smooth-surfaced cap sheet and all base sheets.
 - 2. 12-by-12-inch (300-by-300-mm) square of roofing insulation.
 - 3. 12-by-12-inch (300-by-300-mm) square of walkway pads.
 - 4. 6 insulation fasteners of each type, length, and finish.
 - 5. Flashing and counter flashing.
- D. Installer Certificates: Signed by roofing system manufacturer certifying that Installer is approved, authorized, or licensed by manufacturer to install specified roofing system and is eligible to receive the no dollar limit roofing manufacturer's warranty.

- E. Manufacturer Certificates: Signed by roofing system manufacturer certifying that the roofing system complies with requirements specified in the "Performance Requirements" Article. Upon request, submit evidence of complying with requirements.
- F. Qualification Data: For firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- G. Product Test Reports: Based on evaluation of tests performed by manufacturer and witnessed by a qualified independent testing agency, indicate compliance of components of roofing system with requirements based on comprehensive testing of current product compositions.
 - 1. Indicate compliance of bulk roofing asphalt materials delivered to Project with requirements. Include quantity and statistical and descriptive data for each product. Submit certificate with each load before it is used.
 - 2. Include continuous log showing time and temperature for each load of bulk bitumen, indicating date obtained from manufacturer, where held, and how transported before final heating and application on roof.
- H. Research/Evaluation Reports: Evidence of roofing system's compliance with building code in effect for Project from a model code organization acceptable to authorities having jurisdiction.
- I. Maintenance Data: For roofing system to include in the maintenance manuals specified in Division 1.
- J. Warranty: Sample copy of no dollar limit roofing manufacturer's warranty stating obligations, remedies, limitations, and exclusions of warranty.
- K. Inspection Report: Copy of roofing system manufacturer's inspection report and a qualified independent testing agency's report of completed roof installation.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer to perform Work of this Section who has specialized in installing roofing similar to that required for this Project; who is approved, authorized, or licensed by the roofing system manufacturer to install manufacturer's product; and who is eligible to receive the no dollar limit roofing manufacturer's warranty.

- B. Fire-Test-Response Characteristics: Provide roofing materials with the fire-test-response characteristics indicated as determined by testing identical products per test method indicated below by UL, FM, or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
1. Exterior Fire-Test Exposure: Class A; complying with ASTM E 108, for application and slopes indicated. (Fire rated sheet).
- C. Preliminary Roofing Conference: Before starting roof deck construction, conduct conference at Project site. Meet with the same participants and review the same items listed for the pre-installation conference. In addition, review status of submittals and coordination of work related to roof construction. Notify participants at least 5 working days before conference.
- D. Pre-installation Conference: Before installing roofing system, conduct conference at Project site to comply with requirements of Division 1 Section "Project Meetings." Notify participants at least 5 working days before conference.
1. Meet with Owner; Professional Roof Services, Inc. Representative; Owner's insurer, if applicable; testing and inspecting agency representative; roofing installer; roofing system manufacturer's representative; deck installer; and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
 2. Review methods of removing the existing roofing and insulation. Examine existing roof deck structure, slope and area of replacing roofing for daily output.
 3. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and attachment to structural members.
 5. Review loading limitations of deck during and after roofing.
 6. Review flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect roofing.
 7. Review governing regulations and requirements for insurance, certifications, and inspection and testing, if applicable.
 8. Review temporary protection requirements for roofing system during and after installation.
 9. Review roof observation and repair procedures after roofing installation.

10. Document proceedings, including corrective measures or actions required, and furnish copy of record to each participant.
11. Review all roofing openings, sizes, location, curb or post supports.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store roofing materials in a dry, well-ventilated, weather tight location to ensure no significant moisture pickup and maintain at a temperature exceeding roofing system manufacturer's written instructions. Store rolls of felt and other sheet materials on end on pallets or other raised surfaces. Do not double-stack rolls.
 1. Handle and store roofing materials and place equipment in a manner to avoid significant or permanent damage to deck or structural supporting members.
- B. Do not leave unused felts and other sheet materials on the roof overnight or when roofing work is not in progress unless protected from weather and moisture and unless maintained at a temperature exceeding 50 deg F (10 deg C).
- C. Deliver and store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.
- D. Protect roofing insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with roofing work only when existing and forecasted weather conditions permit roofing to be installed according to manufacturers' written instructions and warranty requirements.
- B. This project requires the use of a state of the art fume recovery system whenever the asphalt kettle is in use. There will be no exceptions unless a self-pumping asphalt tanker is used in lieu of the kettle. ***No kettle may be used unless it is properly equipped with a fume recovery system.***
- C. Fume Recovery System shall be a Garlock Genesis Series FumeGuard or approved equal

1.9 WARRANTY

- A. General Warranty: The warranties specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

- B. No Dollar Limit Roofing Manufacturer's Warranty: Submit a written warranty including roof insulation and all copings and edge metal, without monetary limitation, signed by roofing system manufacturer agreeing to promptly repair leaks in the roof membrane and base flashings resulting from defects in materials or workmanship for the following warranty period. Warranty shall also include a 65 miles per hour wind warranty:
 - 1. Warranty Period: 25 years No Dollar Limit.

- C. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering Work of this Section, including membrane roofing, base flashing, roofing insulation, fasteners, and vapor retarders, if any, for the following warranty period:
 - 1. Warranty Period: 2 years from date of Substantial Completion.

PART 2 – PRODUCTS

2.1 MODIFIED BUILT UP ROOF SYSTEM:

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. SBS Modified Bituminous Sheet:
 - a. Firestone Building Products (The) Basis of Design

 - 2. Acceptable manufactures provided they meet the physical properties of the product and required project supervision
 - 1. GAF
 - 2. Soprema

2.2 TEMPORARY ROOF / VAPOR BARRIER – CONCRETE DECK

- A. APP modified bituminous sheet (Atactic Polypropylene) 165 mil, granule surface modified bitumen roofing membrane strengthened with a fiberglass reinforced with a polyester nonwoven mat.
1. Use: Temporary Roof.
 2. Use: Vapor Barrier over concrete deck.
 3. Reinforcing: Polyester non woven mat
 4. Finish: Black
- B. Physical Properties: Provide APP -modified bituminous membrane materials with the following properties that meets ASTM D 6222, Type I, Grade G when tested according to ASTM D 5147:
1. Thickness: 165 mils minimum.
 2. Net Mass: 95 lbf/100 square feet (4,639 g/ square meter).
 3. Elongation at Peak Load: 30 percent minimum at 73 deg F in each direction.
 4. Tear Strength: 75 lbf. at 73 deg. F (MD). 75 lbf. at 73 deg. F (XMD).
 5. Low-Temperature Flexibility: Pass at minus 32 deg F.
 6. Recycled Content
Post Consumer - 6.0%

2.3 VAPOR BARRIER – STEEL DECK & WOOD DECK

- A. Vapor Barrier Membrane comprised of SBS modified bitumen adhesive, factory laminated to a tri-laminate woven, high density polyethylene top surface.
1. Use: Temporary Roof.
 2. Use: Vapor Barrier membrane over steel deck and wood deck.
 3. Adhesive: SBS modified bitumen
 4. Finish: Polyethylene Top Surface
- B. Physical Properties: Provide a vapor barrier with the following properties that meets ASTM D 903, D 1876, D 1970 when tested according to ASTM D 5147:
1. Thickness: 30 mils minimum.
 2. Tensile Strength: 64 lbf/in. (MD). 88 lbf/in. (CMD).
 3. Ultimate Elongation, Bitumen Portion: 52 percent minimum at 73 deg F.
 4. Tear Strength: 84 lbf. at 73 deg. F (MD). 90 lbf. at 73 deg. F (XMD).
 5. Low-Temperature Flexibility: Pass at minus 31 deg F.
 6. Recycled Content: 0.0%

2.4 MODIFIED BUILT UP ROOF SYSTEM BASE SHEETS:

- A. Type VI glass felt.
 - 1. ASTM D 2178 60 lbf/in md, 60 lbf/in cmd

2.5 MODIFIED BUILT UP ROOF SYSTEM CAP SHEET:

- A. SBS modified bituminous sheet (Styrene-Butadiene- Styrene) 158 mil, mineral surfaced rubber modified roofing membrane reinforced with a polyester scrim mat.
 - 1. Use: Roof membrane.
 - 2. Use: Finish ply of 3-ply, modified bituminous membrane roofing system.
 - 3. Reinforcing: Polyester
 - 4. Finish: Gray mineral
- B. Physical Properties: Provide SBS -modified bituminous membrane materials with the following properties when tested according to ASTM D 5147:
 - 1. Thickness: 158 mils minimum.
 - 2. Tensile Strength: 80 lbf/in. at 73.4 deg F (MD). 80 lbf/in. at 73.4 deg F (CMD).
 - 3. Elongation at Maximum Load: 5 percent minimum at 73.4 deg F in each direction.
 - 4. Tear Strength: 128 lbf. at 73.4 deg. F (MD). 128 lbf. at 73.4 deg. F (CMD).
 - 5. Low-Temperature Flexibility: Pass at minus 15 deg F.
 - 6. Recycled Content
Post Consumer - 5.0%
- C. Physical Properties: White Surface Coating for Roof Membrane and Flashings:
 - 1. Color – White.
 - 2. Weathering, ASTM D 4798 - No Deterioration over 1000 hours per ASTM G26 Test Requirements.
 - 3. Non-Volatile, ASTM D 1644 - 66% min.
 - 4. Density @77° F, ASTM D 1475 - 12 lb/gal.
 - 5. Elongation, ASTM D 2370 - 250% minimum.
 - 6. Tensile Strength, ASTM D 2370 - 250 psi minimum.
 - 7. Toxicity - Non-Toxic: Water based.
 - 8. Wet Film Thickness @ 2 gal. - 32 mils.

9. VOC - 70 g/l.
10. Emittance = 94%
11. Reflectivity = Typical 81%
12. SRI = 101

D. Physical Properties: Provide SBS -modified bituminous flashing membrane materials with the following properties when tested according to ASTM D 5147:

1. Flashing Surface Ply:
 - a. Thickness: 158 mils minimum.
 - b. Tensile Strength: 80 lbf/in. at 73.4 deg F (MD). 80 lbf/in. at 73.4 deg F (CMD).
 - c. Elongation at Maximum Load: 5 percent minimum at 73.4 deg F in each direction.
 - d. Tear Strength: 128 lbf. at 73.4 deg. F (MD). 128 lbf. at 73.4 deg. F (CMD).
 - e. Low-Temperature Flexibility: Pass at minus 15 deg F.
 - f. Recycled Content
Post Consumer – 5.0%
2. Flashing Base Ply:
 - a. Thickness: 90 mils minimum.
 - b. Elongation at Maximum Load: 4 percent minimum at 73.4 deg F in each direction.
 - c. Tear Strength: 109 lbf. at 73.4 deg. F (MD). 107 lbf. at 73.4 deg. F (CMD).
 - d. Low-Temperature Flexibility: Pass at minus 22 deg F.
 - e. Recycled Content
Post Consumer – 5.0%

2.6 AUXILIARY MEMBRANE MATERIALS

- A. General: Furnish auxiliary materials recommended by roofing system manufacturer for intended use and compatible with SBS-modified bituminous roofing.
 1. Furnish liquid-type auxiliary materials that meet VOC limits of authorities having jurisdiction.

- B. Roofing Asphalt:
1. Type IV steep asphalt for slopes $\frac{1}{4}$ " or less
- C. Asphalt Roofing Cement: ASTM D 2822, asbestos free, VOC compliant as provided by the Membrane manufacturer and silver in color throughout the thickness
- D. Mastic Sealant: Polyisobutylene, plain or modified bituminous, nonhardening, nonmigrating, nonskinning, and nondrying.
- E. Flashing Cement for exposed surfaces: Silver roof cement
- F. Fasteners: Factory-coated steel fasteners and metal plates complying with corrosion-resistance provisions of FM 4470; designed for fastening base sheets, base-ply felts, and base flashings and for backnailing modified bituminous membrane to substrate; tested by manufacturer for required pullout strength; and acceptable to roofing system manufacturer.
- G. Asphalt Primer: ASTM D 41 - VOC compliant.
- H. Cants: Wood fiber or perlite
- I. Urethane Sealant: One part, non-sag sealant as recommended and furnished by the membrane manufacturer for moving joints.
1. Tensile Strength (ASTM D412) 250 psi
 2. Elongation (ASM D412) 950%
 3. Hardness, Shore A (ASTM C920) 35
 4. Adhesion-in-Peel (ASTM C920) 30 pli
- J. Pitch Pocket Sealer: Two part, 100% solids, self leveling, polyurethane sealant for filling pitch pans as recommended and furnished by the membrane manufacturer.
1. Durometer (ASTM D2240) 40-50 Shore
 2. Elongation (ASTM D 412) 250%
 3. Tensile Strength (ASTM D 412) 200 @ 100 mil
- K. Pitch pans, Rain Collar 24 gauge stainless or 20oz (567gram) copper. All joints should be welded/soldered watertight. See details for design
- L. Drain Flashings should be 4lb (1.8kg) sheet lead formed and rolled

- M. Plumbing stacks should be 4lb (1.8kg) sheet lead formed and rolled.
- N. Miscellaneous Accessories: Provide miscellaneous accessories recommended by roofing system manufacturer for intended use.
- O. Rust Inhibitive Paint: As recommended and furnished by the membrane manufacturer for mechanical units and other metal surfaces to control and prevent surface rust.
- P. Acrylic Surfacing: White acrylic coating that meets ASTM D6083.
- Q. New drains shall be cast iron drains as manufactured by Smith, Josum, Titan or approved equal. All replacement drain strainers must fit the existing drain perfectly and be CAST IRON. All replacement drains shall be equal to or greater than the size it replaces. Include no hub fittings and under deck clamping devices.

2.7 INSULATION MATERIALS

- A. Tapered and Flat Polyisocyanurate Board Insulation: Rigid, cellular Polyisocyanurate thermal insulation with core formed by using HCFCs as blowing agents complying with ASTM C 1289.
 - 1. Facer Type: Type II, felt or glass-fiber mat on both major surfaces.
 - 2. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.
- B. Gypsum Based Insulation Board:
 - 1. Qualities: Gypsum-Fiber Roof Board.
 - a. Board size: 4' x 4' or 4' x 8'
 - b. Thickness: Minimum 1/4".
 - c. Compressive Strength – 1,800 psi.
 - d. Fire Performance (ASTM E 84) – Flame Spread 5, Smoke Developed 0.
 - e. Mold Resistance (ASTM D 3273) – 10.
 - f. Recycled Materials – 95%.

2.8 INSULATION ACCESSORIES

- A. General: Furnish roofing insulation accessories recommended by insulation manufacturer for intended use and compatible with sheet roofing material.
- B. Mechanical Fasteners - Firestone All-Purpose fasteners and 3 inch steel insulation plates.
- C. I.S.O. Stick low rise urethane foam insulation adhesive: Highly elastic, one step, VOC compliant low rise adhesive for use adhering insulation to vapor barrier/temporary roof and coverboard to insulation as specified.
- D. Tapered Edge Strips: Rigid, cellulosic-fiber insulation board, complying with ASTM C 208, Type 2.

2.9 ROOF WALKWAYS

- A. Walkway Pads: Factory formed recycled rubber, nonporous, with a slip-resisting surface texture, manufactured specifically for adhering to modified bituminous membrane roofing as a protection course for foot traffic, of the following thickness:
 - 1. $\frac{3}{4}$ " thick for use in high traffic areas
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Supplied by membrane manufacturer or approved equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions under which roofing will be applied, with Installer present, for compliance with requirements.
- B. Verify that roof openings and penetrations are in place and set and braced and that roof drains are properly clamped into position.
- C. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at roof penetrations and terminations and match the thicknesses of insulation required.
 - 1. Verify that wood nailer strips are located perpendicular to roof slope and are spaced according to requirements of roofing system manufacturer.
- D. Do not proceed with installation over concrete decks until after the minimum concrete curing period recommended by roofing system manufacturer.
 - 1. Test concrete substrate for excessive moisture by pouring 1 pint (0.5 L) of roofing asphalt at equiviscous temperature on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.

- E. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch (1.5 mm) out of plane.
- F. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Inspect the deck to verify integrity. Bring any areas of questionable integrity to the Owner's attention. Do not cover any areas of questionable deck or deck out of plane.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. The following specifications will be used for the roof replacement at the State Police Firing Range Building. No deviation from the specifications or details will be permitted without the written consent of the Consultant and the State of Delaware's Project Manager.
- B. Sequence of Construction:
 - 1. The existing roof system will be removed to the deck. The temporary roof will be installed to make the building watertight.
 - 2. Contractor under this contract will remove the abandoned equipment, cover openings in deck, install temporary roof over curb removal points and then install the insulation and roof system as specified.
 - 3. Vapor barriers and insulation will be installed as specified.
 - 4. Roof system to be two plies of Type VI fiberglass felts and one ply of approved SBS modified mineral surfaced membrane in Type IV No Smell asphalt.
 - 5. Flashings to be a two-ply construction.
 - 6. New edge metal and drains will be installed as specified.

1.0 ROOF REMOVAL / METAL, CONCRETE & PLYWOOD DECKS:

- 1.1 No more roof area than can be made into a watertight condition will be removed in a single day. Set-up areas are shown on the drawing.
- 1.2 Contractor will have trucks or dumpsters available for removal of debris. Roof debris will not be stored on the roof or on adjacent roof areas. Old roofing, insulation and debris will be placed into trucks or dumpsters at the designated set-up area. Tarpaulins will be used to protect the building elevations from dirt and dust contamination. Set-up areas are shown on the drawing.
- 1.3 Roof removal will not be started unless materials are on site for installation of new roof.
- 1.4 Existing single ply roof systems will be removed to the structural decks.
- 1.5 Removal:
 - a. Metal - Where the existing roof system will be removed to the steel deck, repair defects as required. Flutes of the steel deck will have any water removed and flutes will be examined for rust. Where rust is found, the deck will be treated with Red Oxide Primer applied at 300 square feet per gallon. Primer will be allowed to dry. Any steel decking that is rusted through will be called to the attention of the State's Project Manager. Areas of heavy scaling rust will be wire brushed prior to application of primer. Unattached steel decking will be re-secured with Tek-3 screws.
 1. Contractor will include in Base Bid, pricing for 200 square feet of steel deck repair as described above using the Red Oxide Primer.
 2. Contractor will include in Base Bid, pricing for 200 square feet of steel deck replacement based on "nesting" new decking over existing.
 - b. Concrete - The existing roof system will be removed to the concrete plank decking. On Concrete Decks, removal may be planned for maximum production. Repair defects as required. Deteriorated or cracked decking will be brought to the attention of the State of Delaware's Project Manager.

- c. Wood Deck - The existing roof system will be removed to the plywood deck. The wood deck will be examined. Any wood decking found to be deteriorated will be brought to the attention of the Project Administrator. Replacement of wood decking will be done with 5/8" CDX plywood. Check all supports and replace or reinforce where necessary.
- 1.6 Recycling:
- a. Contractor shall make necessary arrangements to recycle the existing edge metal.
- 1.7 Obsolete equipment removal will require repair of any voids in the deck the same day. Barricades will be securely placed around the decking voids and will be at least four feet high and clearly marked "Danger". Barricades will be positioned immediately after removal of equipment.
- 1.8 Old roofing, insulation and debris will not be thrown into trucks or dumpsters but placed within chutes or other conveyance to ground. Tarpaulins will be used to protect the building elevations from dirt and dust contamination.
- 1.9 Drains will be plugged during tear-off operations and re-opened the same day. **Drains and scuppers will not be plugged over night.** Any drains that are plugged or non-functioning will be brought to the attention of the State's Representative.
- 1.10 Due to concurrent operations below roof areas, all precautions must be taken to insure a watertight condition. Contractor will provide emergency telephone number to the State's Project Manager.
- 1.11 Access to roofs will be through an extension ladder. Dumpsters will be placed along side the building at designated areas. Any crane operations must be approved by the State's Project Manager at least 48 hours in advance.
- 1.12 Lay down area for materials will be at a location designated by the Project Manager.
- 2.0 STRUCTURAL CONCRETE DECK REPAIRS:**
- 2.1 LOCATION OF WORK
- A. Repairs to deteriorated sections of the structural concrete decking after removal of the single ply roof system.

- B. Contractor will include, on the enclosed Bid Form, the cost for 500 square feet of concrete deck repairs based on ½ inch thicknesses.

2.2 MATERIALS

- A. Bonding Coat & Reinforcement Protection - Sika Armatec 110 EpoCem or equal.
- B. Top Coat - SikaTop 123 Plus or equal.

2.3 SCOPE OF WORK

- A. ARMATEC 110 EPOCEM:
 - 1. Surface Preparation - Cementitious substrates should be cleaned and prepared to achieve a laitance and contaminant free open textured surface by blast-cleaning or equivalent mechanical means. Substrate must be saturated surface dry without standing water. Steel should be cleaned and prepared thoroughly by blast-cleaning.
 - 2. Mixing - Shake contents of both Component “A” and Component “B”. Empty entire contents of both Component “A” and Component “B” into a clean dry mixing pail. Mix thoroughly for 30 seconds with a Sika paddle on a low speed (400-600 rpm) drill. Slowly add the entire contents of Component “C” while continuing to mix for 3 minutes until blend is uniform and free of lumps. Mix only that quantity that can be applied within its pot life.
 - 3. Application - As a bonding agent, apply by stiff-bristle brush or broom. Spray apply with Goldblatt Pattern Pistol or equal equipment. For best results, work the bonding slurry well into the substrate to ensure complete coverage of all surface irregularities. Apply the freshly mixed patching mortar or concrete wet on wet, or up to the maximum recommended open time, onto the bonding slurry.

Maximum recommended open time between application of Armatec 110 and patching mortar or concrete:

95 F - 6 hours
68 F - 12 hours
50 F - 16 hours
40 F - 24 hours

For Corrosion protection - Apply by stiff-bristle brush or spray at 80 square feet / gallon. Take special care to properly coat all sides of the totally exposed steel. Allow coating to dry 2-3 hours at 73 degrees F., then apply a second coat at the same coverage. Allow to dry again before repair mortar or concrete is applied.

B. SIKATOP 123 PLUS:

1. Mixing - Pour Component "A" into mixing container. Add Component "B" while mixing continuously. Mix mechanically with a low speed drill (400-600 rpm) and mixing paddle or mortar mixer. Mix to a uniform consistency, maximum 3 minutes. Manual mixing can be tolerated only for less than a full unit. Thorough mixing and proper proportioning of the two components is necessary.
2. Application & Finish - SikaTop 123 Plus must be scrubbed into the surface, filling all pores and voids. Force material against edge of repair, working toward center. After filling repair, consolidate, then screed. Material may be applied in multiple lifts. The thickness of each lift shall not be less than 1/8 inch minimum or more than 1/2 inches maximum. Where multiple lifts are required, score top surface of each lift to produce a roughened surface for the next lift. Allow preceding lift to reach final set, 30 minutes minimum, before applying fresh material. Saturate the surface of the lift with clean water. Scrub fresh mortar into preceding lift. Allow mortar or concrete to set to desired stiffness, then finish with a wood or sponge float for a smooth surface.
3. Curing - As per ACI recommendations for Portland cement concrete, curing is required. Moist cure with wet burlap and polyethylene, a fine mist of water or a water based compatible curing compound. Curing compounds adversely affect the adhesion of following lifts of mortar, leveling mortar or protective

coatings. Moist curing should commence immediately after finishing. If necessary, protect newly applied material from direct sunlight, wind, rain and frost.

3.0 ABANDONED PROJECTION REMOVAL:

- 3.1 Existing abandoned projections that will be removed as part of the roofing project are noted on the drawing in red. The existing concrete plank supports and 2' x 2' pavers will also be removed from the roof. There are additional projections HVAC Units, Ductwork, Associated Supports etc.... that may be removed depending on the alternates taken as part of the HVAC Upgrade project. Demolition of these projections will be performed by others. See DEDC and Harvard Environmental project drawings and specifications for specific information on which existing projections will be removed and which will remain.
- 3.2 Where Openings in the Concrete Deck exceed 1' x 1': (Detail #D-AP-150)
- a. The abandoned projections and curbs will be removed. Workmen must wear safety harnesses when working within 6 feet of the opening in the deck.
 - b. Wood blocking will be installed around perimeter of opening. Grade "A" wood blocking will be secured to the deck with two (2) rows of approved fasteners spaced every 18 inches on center, staggered pattern. One (1) fastener will be located within two inches of the blocking ends.
 - c. On the north and south side of the opening, install a 2"x2"x1/4" angle to the inside face of the wood nailer. Angle will be fastened to the wood blocking with approved fasteners spaced every 8 inches on center. Fasteners must penetrate wood blocking by a minimum of 2 inches.
 - d. Across the angle iron, install 2" x 4" lumber every 12 inches on center. 2"x4" lumber will be Grade "A" and will be fastened to the angles with self-tapping metal screws. Over the 2"x4" lumber install a solid layer of 1/2" CDX plywood that will completely cover the opening. Plywood will be fastened to the 2"x4" lumber with spiral shanked nails spaced every 8 inches on center.
 - e. Cover the exposed wood with the Self Adhered Base Sheet as described in Section 32.0 of this specification.

- f. The polyisocyanurate insulation will butt up tightly to the wood blocking. Across the temporary roof over the plywood, in-fill with polyisocyanurate insulation match height of the surrounding polyisocyanurate insulation.
 - g. Over the polyisocyanurate insulation install the ¼ ” Dens Deck Prime Coverboard and the roof system as specified.
- 3.3 Where openings in the Steel Deck exceed 1’ x 1’: (Detail #D-AP-155):
- a. The abandoned projections and curbs will be removed. Workmen must wear safety harnesses when working within 6 feet of the opening in the deck.
 - b. Where holes in decking are larger than 1’ x 1’, structural decking will be replaced with new 22 gauge painted decking.
 - c. New oversize metal decking will overlap onto existing metal decking and span joist to joist. New metal decking will be secured to the existing metal decking with Tek-3 fasteners spaced every 8 inches on center.
 - d. Metal deck fasteners shall be FMRC approved as indicated in the latest edition of the 2013 Factory Mutual Approval Guide and all applicable supplements.
 - e. New isocyanurate and Dens-Deck insulation will be installed over the metal decking or aluminum plate as specified.
- 3.4 Openings of 1’ x 1’ and less: (Detail #D-AP-160)
- a. Small holes in the deck, less than 12”x 12”, will be covered with a 1/4" aluminum plate at least 8 inches wider than the opening. Plates will be secured to the structural deck with approved fasteners at an interval not less than every 6 inches on center. A minimum of four (4) fasteners per plate will be required. Plate will be covered with the temporary roof and insulation as specified below. Special precautions will be taken where fasteners are required. Contractor will make sure no conduits, below the decking, will be damaged from the installation of the mechanical fastener.

3.5 During demolition, inside of building under the abandoned projections, must be protected from falling debris. This may be accomplished by the use of polyethylene or clean tarps. Contractor will remove all debris and clean area at the end of each days work. Scheduling and placement of interior protection must be closely coordinated and approved by the State's Project Manager.

3.6 The contractor will be responsible to remove all dirt and debris left by the removal of the overhead protection. This cleanup will also include the cleaning of the floor by a wet or dry vacuum to minimize dust. Sweeping of the floor by broom or other device is not acceptable. The State's Project Manager will make final acceptance of the cleaning.

4.0 PRIMING OF CONCRETE DECK:

4.1 The deck will be swept of all dust, dirt and debris. Deteriorated concrete decking will be brought to the attention of the Project Manager.

4.2 Penetrations though the deck for vents, pipes, or joints in the deck construction will be sealed up to prevent any water, bitumen or other materials from penetrating into the building. Construction joints should be filled with closed cell joint backing and a dry felt should be placed over the joint. The dry felt will extend a minimum of two inches on each side of the joint and be sealed with asphalt mastic. Felt should be an approved asphalt coated base sheet.

4.3 After cleaning and repair of the openings in the deck surface, prime the surface with an approved asphalt quick drying ASTM D-41 primer at the rate of 3/4 to 1 1/4 gallon per 100 Square feet. Areas of high absorption resulting in an off white appearance will require re-priming. Allow primer to dry.

5.0 TORCH APPLIED TEMPORARY ROOF/VAPOR BARRIER CONCRETE DECK, ROOF AREAS # 3 & # 4:

5.1 Beginning at the low point of the roof, fully torch weld one (1) ply of Firestone APP 180 heat weld granule surface membrane, lapping sides a minimum of 3.0 inches and ends a minimum of 4.0 inches.

5.2 Starting at the low point, torch one ply of the Firestone APP 180 sheet. Completely remove the roll wrapping tape before membrane installation. The first roll of APP membrane is unrolled completely and aligned. Remaining rolls shall be unrolled approximately halfway in order to properly align the 5 inch side laps and ensure the 6 inch end laps are maintained.

- 5.3 Torch apply the rolled portion of the Firestone APP 180 membrane by passing the flame of the torch evenly across the face of the roll. Heat the membrane with the torch until it develops a sheen or glossy appearance. Apply heat to the seam area of the previously installed sheet as well. The welding temperature is usually correct when a flow of bitumen approximately 1/2 inch wide is seen coming from the side lap (do not feather or trowel side laps). Roll up the unadhered half of the membrane sheet and repeat the above procedure to complete the installation of the roll.
- 5.4 Each ply shall be pressed (broom or squeegee) into place to assure total adhesion and that the ply is free of air pockets, wrinkles, fishmouths, or open laps.
- 5.5 At the end of each day's work, install water cut-offs anywhere moisture could enter the assembly. Remove cut-off before resuming work.
- 5.6 Before leaving the job site all laps will be probed with a cotter pin puller. Open laps, fishmouths or mole runs must be sealed every day. Re-heat sheet and press into position of cover opening with two plies of reinforcing fabric centered over the opening. Fabric will be comprised of a 6 inch and 12 inch layer set in and top dressed with asphalt mastic.
- 5.7 When flashings are not immediately installed, strip edge of membrane to seal out moisture.
- 5.8 At all intersections of the plane of the roof, walls, curbs or other raised edges, install cant or tapered edge strips. Extend roofing felts to the top of the cant but not more than two (2) inches above. At flat or raised edges, extend felts to the edge of the building, installing a felt envelope as required.
- 5.9 Before torch application begins, all wood surfaces will be covered one (1) ply of the self-adhered base sheet as described below in Section 32.0.

6.0 VAPOR BARRIER SYSTEM / METAL DECK, ROOF AREA # 1:

- 6.1 Over the metal decking, install the V-Force Vapor Barrier Membrane by Firestone Building Products.
- 6.2 Roll out the V-Force Vapor Barrier membrane over clean, dry metal deck. The width of the membrane is designed to match perfectly with the top flute of the deck.

- 6.3 Once the membrane is in place, while holding the membrane tight, peel off the plastic release film by pulling diagonally.
- 6.4 Install subsequent rolls of membrane in the same way, taking care to overlap the longitudinal joints by 3 in (7.5 cm).
- 6.5 At the end of the roll, install a metal plate (6x42in-15x106 cm) to support the membrane end lap between the metal flutes ensuring a complete end lap seal. Overlap 6 in (15cm).
- 6.6 The membrane's strength offers extra protection from foot traffic during installation. The slip resistant surface allows for safe movement across the roof.
- 7.0 VAPOR BARRIER SYSTEM / PLYWOOD DECK, ROOF AREA # 2:**
- 7.1 The wood deck will be cleaned of all dirt and debris. Deteriorated structural decking will be brought to the attention of the Project Coordinator.
- 7.2 Penetrations through the deck for vents, pipes or joints in deck construction will be sealed to prevent materials penetrating the interior.
- 7.3 Wood Decking:
 - a. Wood Decking repairs will be completed and examination of perimeter blocking, nailers, and cants will be completed. Required materials for repairs will be on site or promptly available.
 - b. Wood Decking will be replaced in kind or small repairs may be completed with .040 aluminum sheeting screwed into place. Reinforcement will extend at least 3 inches beyond deterioration. Deterioration larger than 1 square foot in areas will be replaced.
 - c. Over the wood decking, install the V-Force Vapor Barrier Membrane by Firestone Building Products.
 - d. Roll out the V-Force Vapor Barrier membrane over plywood deck primed with either Firestone SA water based primer or Firestone SA solvent based primer.
 - e. Once the membrane is in place, while holding the membrane tight, peel off the plastic release film by pulling diagonally.

- f. Install subsequent rolls of membrane in the same way, taking care to overlap the longitudinal joints by 3 in (7.5 cm).
 - g. At the end of the roll, overlap 6 in (15cm) in order to ensure a complete end lap seal on the latitudinal joint.
- 7.4 The membrane's strength offers extra protection from foot traffic during installation. The slip resistant surface allows for safe movement across the roof.

8.0 VERTICAL CONCRETE REPAIRS:

- 8.1 Work will take place on the concrete walls that surround roof areas 3 and 4.

ERODED / SPALLED CONCRETE:

1.0 LOCATION OF WORK

- A. Where existing concrete has eroded or has spalled off the façade.

2.0 MATERIALS

- A. Material will be ALL-CRETE 20 Rapid setting cementitious patching material as manufactured by ChemRex.

3.0 SCOPE OF WORK

- A. Surface Preparation:

- 1. Concrete - All substrates should be cleaned and free of dust, plaster, oil, paint, grease, corrosion deposits, loose concrete, stucco and any other contaminants. Excess laitance should be removed by mechanical means. Smooth substrates must be mechanically roughened by scrubbing or needle gun to provide an adequate anchor profile. Presoak the prepared concrete surface to the point of saturation with no standing water.

For concrete repair in all areas:

- a. Saw cut concrete $\frac{3}{4}$ " back at spalled areas to reach solid concrete.
- b. Remove all loose and spalled concrete.
- c. Where concrete has been removed to a depth of 2 inches

or more, install ¼ inch stainless steel dowels at the rate of one every 6 inches.

- d. Rebuild with ALL-CRETE 20.

B. Bonding Agents:

1. In areas where prewetting with water is impractical, use ThoRoc Epoxy Adhesive 24LPL as a 24 hour open time epoxy bonding agent/rebar primer. Apply to both concrete and steel. ThoRoc Epoxy Adhesive 24LPL can be applied to cured ThoRoc Zinrich Rebar Primer.

C. Mixing:

1. Water ratios of 4 to 5 quarts per 50 pounds of powder will produce a mixed consistency from putty to plastic depending upon handling preference and job requirements. Add All-Crete 20 to water and mix for 2 minutes, using a slow speed drill (400-600 rpm) and suitable mixing blade or by hand. Please note that mixing time, mixed consistency, and set will be affected by the temperature of the substrate, water, material, and air.

D. Application:

1. Material should be placed into layers no greater than 3.0 inches at a time. Apply scrub coat of the mixed material by brushing it into the substrate. While scrub coat is still wet, apply All-Crete 20, ensuring good compaction of the mortar by tamping or troweling on both horizontal and vertical substrates. Initial set will occur in 8 to 12 minutes, with final set in 15 to 20 minutes.
2. If at all possible, texture outside surface of patch to match textured surface of surrounding walls.

8.2 CRACKS IN CONCRETE WALLS:

2.1 LOCATION OF WORK:

- A. Cracks in the vertical concrete walls.

2.2 MATERIALS:

- A. Material will be Two Component, Non-Sag Polyurethane Sealant: Sonneborn NP2. Color to be selected by State's Project Manager.

2.3 SCOPE OF WORK:

A. PREPARATION:

1. Remove loose materials and foreign matter, which impair adhesion of joint filler.
2. Clean cracks in vertical walls by grinding, sandblasting, or wire brushing to expose a sound surface free of contamination and laitance.
3. Ensure structurally sound surfaces, dry, clean, free of dirt, moisture, loose particles, oil, grease, asphalt, tar, paint, wax, rust, waterproofing, curing and parting compounds, membrane materials, and other foreign matter.
4. Where the possibility of joint filler staining of adjacent areas or materials exists, mask joints prior to application.
 - a. Do not remove masking tape before joints have been tooled and initial cure of joint filler has taken place.
 - b. Work stained due to failure of proper masking precautions will not be accepted.

B. INSTALLATION:

1. Back-Up Material:
 - a. Install appropriate size backer rod, larger than joint where necessary according to manufacturer's recommendations.
 - b. Install polyethylene joint filler in joints wider than 1/4 inch (6 mm) to back-up material per manufacturer's recommendations.
 - c. Do not install epoxy joint filler over backer rod.
2. Bond Breaker: Install bond-breaker strip in joint to be sealed on top of back-up material to prevent adhesion of sealant to back-up material; install per manufacturer's recommendations.

3. Sealant:
 - a. Prepare sealants that require mixing; follow manufacturer's recommended procedures, mixing thoroughly.
 - b. Mix only as much material as can be applied within manufacturer's recommended application time period.
 - c. Apply materials in accordance with manufacturer's recommendations; take care to produce beads of proper width and depth, tool as recommended by manufacturer, and immediately remove surplus sealant.
 - d. Apply materials only within manufacturer's specified application life period. Discard sealant after application life is expired or if prescribed application period has elapsed.

4. Epoxy Joint Filler:
 - a. Transfer entire contents of activator container thoroughly with entire contents of base container in separate container of appropriate size.
 - b. Mix only as much material as can be applied within manufacturer's recommended application time period.
 - c. Mix with slow-speed drill (80-100 rpm) and slotted paddle. Ensure mixing paddle reaches bottom and scrapes side of container several times. Scrape paddle several times to ensure thorough mixing. Keep paddle blade below surface to avoid whipping air into material.
 1. Mix Epolith(R)-P for 5 to 7 minutes.
 - Mix Epolith(R)-G for 8 to 10 minutes.
 - d. Pour Epolith(R)-P from spouted can or professional bulk-loading caulking gun.
 - e. Apply Epolith(R)-G by professional bulk-loading gun.
 - f. Maintain minimum joint application of 2/3 joint depth or 1 inch (25 mm), whichever is greater.
 - g. Fill joints from bottom up to exterior face by holding properly sized nozzle against joint bottom.
 - h. Tool joint to ensure maximum adhesion to joint sides, correct bead configuration, and a neat joint. Dry tool or dampen tool with Reducer 990. Do not use water or soapy water.
 - i. Apply materials only within manufacturer's specified application life period. Discard joint filler after application life is expired or if prescribed application period has elapsed.
 - j. Over caulking, apply sand to match texture of surrounding surface.

C. CLEANING:

1. Remove uncured sealant and joint filler with Reducer 990, xylene, toluene, or MEK. Remove cured sealant and joint filler by razor, scraping, or mechanically.
2. Remove all debris related to application of sealants from job site in accordance with all applicable regulations for hazardous waste disposal.

9.0 INSULATION / FLAT STOCK AND TAPERED CRICKETS METAL, CONCRETE AND PLYWOOD DECKS:

- 9.1 The surface of the vapor barriers and temporary roofs must be cleaned using compressed air, vacuum equipment or hand/power brooms to remove dust, loose dirt or debris.
- 9.2 All blocking and cants will be installed at edges, curbs, pitch pockets and supports as required by detail specifications. Project work will only be performed in areas to receive roofing system the same day.

9.3 Insulation to be used:

a. Roof Area 1:

1. 5.2 inches of polyisocyanurate insulation (2 layers 2.6" + 2.6") mechanically fastened to the deck.
2. Tapered polyisocyanurate crickets with 1" per foot slope between the drains running down the middle of this roof area mechanically fastened to the deck.
3. ¼ " Dens Deck Prime insulation as cover board adhered over the polyisocyanurate insulation in a solid application of I.S.O. Stick Adhesive.

b. Roof Area 2:

1. 5.2 inches of polyisocyanurate insulation (2 layers 2.6" + 2.6") mechanically fastened to the deck.
2. Tapered polyisocyanurate crickets with ½" per foot slope will be installed along the south wall between the drains and the drains and the perimeter walls will be mechanically fastened to the deck.
3. ¼ " Dens Deck Prime insulation as cover board adhered over the polyisocyanurate insulation in a solid application of I.S.O. Stick Adhesive.

c. Roof Areas 3 & 4:

1. 5.2 inches of polyisocyanurate insulation (2 layers 2.6" + 2.6") adhered to the deck in a solid application of I.S.O. Stick Adhesive.
2. Tapered polyisocyanurate crickets with 1" per foot slope will be installed along the east wall of Roof Area 3 and the West wall of Roof Area 4 between the scuppers and the scuppers and perimeter walls will be adhered to the base layers of polyisocyanurate insulation in I.S.O. Stick Adhesive.
3. ¼ " Dens Deck Prime insulation as cover board adhered over the polyisocyanurate insulation in a solid application of I.S.O. Stick Adhesive.

9.4 Securement –Concrete Deck, Roof Areas 3 & 4:

All layers of insulation will be installed in solid applications of I.S.O. Stick Adhesive. Review the roofing insulation plan. Polyisocyanurate insulation boards cannot be larger than 4 feet x 4 feet. Multiple layers of boards should use the staggered joint method of application. Compatible insulation other than polyisocyanurate can be 4 feet x 8 feet maximum size.

A. Product Installation:

1. Using PaceCart 2:
 - a. Install Part 1 and Part 2 components following instruction on Bag-in-Box package.

- b. Open flow valves on the dispenser completely and turn machine on. This allows adhesive to be pumped at a 1:1 ratio through the disposable mix tip and onto the substrate in a semi-liquid state.
 - c. Apply fluid mixture in $\frac{3}{4}$ to 1 inch wide wet beads spaced maximum of 4 inches on center that spreads in excess of 2 inches wide while rising $\frac{3}{4}$ to 1 inch.
 - d. Lay insulation board into place and walk-in to assure complete adhesion. Curing typically occurs in 4 to 8 minutes depending on temperature and weather conditions.
 - e. Check with roof system manufacturer for project specific spacing requirements.
3. Typical Application Rates:

Application rates vary depending on surface roughness and absorption rate of the substrate. Typical coverage rates for I.S.O. Stick Adhesive dispensed through the PaceCart 2 are 10-20 squares per 10 gallon Bag-in-Box sets. Typical coverage rates for I.S.O. Stick Adhesive dispensed through SpotShot applicators is 4-6 squares per case (4 sets of 1500 ml cartridges). All coverage rates are based on 12 inch on center maximum spacing. See chart below for typical application rates on specific substrates.

Application Rates (Bag-in-Box Dispensed from PaceCart2)	Typical Coverage Squares/Gallon
Insulation to Concrete	1.7 to 2
Insulation to Insulation	1.7 to 2
Insulation to Smooth Bur	1.5 to 1.7
Insulation to Modified Bitumen	1.5 to 1.7
Insulation to Gypsum	1 to 1.2
Insulation to Lightweight Concrete*	1 to 1.7
Insulation to Wood	1.7 to 2
Insulation to Cementitious Wood Fiber	1 to 1.2
Insulation to Steel	1 to 1.2

4. Reaction Time:

It is important to monitor the speed of the reaction in relation to the temperature (substrate and ambient) at time of application to ensure a complete reaction. Note the charts below for correct ‘Part 2’ component selection:

Typical Reaction Time Characteristics

a. 5 Gallon Bag-in-Box Packaging

Temperature	Part 2 Formula	Tack Free Time (minutes)	Set Up Time (minutes)
40°F+	R	3-5	10-12

b. 1500 ml SpotShot Cartridges

Temperature	Part 2 Formula	Tack Free Time (minutes)	Set Up Time (minutes)
0°F-40°F	W	3-4	10-12
40°F+	R	3-5	10-12

Important: When applying I.S.O. Stick Adhesive, board stock must be placed into the adhesive shortly after it has reached its maximum rise while it is still wet and tacky and before it reaches its tack free state.

9.5 Securement – Metal Deck & Plywood Deck, Roof Areas 1 & 2:

a. Metal Deck & Plywood Deck: Mechanically fasten designated layers of insulation, to the structural deck, with Buildex Roofgrip #12 fasteners and 3 inch disc through the metal deck. Fasteners must penetrate the metal deck by at least 3/4 inch.

b. FM I-90 approved fastening pattern for insulation:

Field: - 1 fastener per every 2.0 square feet
 - 8 fasteners per 4' x 4' board
 - 16 fasteners per 4' x 8' board

Perimeter - 1 fastener per 1.5 square feet
 - 21 fasteners per 4' x 8' board
 - Perimeters are:
 - Roof Areas 1 & 2= 4 feet

Corners - 1 fastener per 1 square feet
 - 32 fasteners per 4' x 8' board
 - Corners are:
 - Roof Area 1 & 2= 4 feet x 4 feet

9.6 Install no more insulation than can be covered with new roofing membrane the same day. No phased construction of roofing membrane is acceptable.

- 9.7 Insulation panels will have joints staggered. Joints in upper layers of insulation will be a minimum of 6 inches away from joints in the lower layers of insulation. Gaps between panels of insulation will not exceed 1/8 inch at wood blocking and joints in the field of insulation will be tight. Panels with broken corners, damaged facers or wet panels of insulation will not be used.
- 9.8 Compressive strength of isocyanurate insulation will be a minimum of 20 psi.
- 9.9 Plastic shipping wrappings on insulation will be removed at time of site delivery and insulation will be covered with tarpaulins.
- 9.10 Isocyanurate insulation must meet Factory Mutual approval for a Class 1 roofing construction per FMRC Standard 4450/4470, Federal Specifications HH-I-1972/GEN, BOCA section 2002.0, ICBO section 1713 and SBCCI section 717.
- 9.11 Due to thickness of insulation, insulation panels will need to be pressed in place and cut to contour of roof area.

10.0 COVERBOARD / DENS-DECK PRIME – ADHERED, ALL ROOF AREAS:

- 10.1. All blocking and cants will be installed at edges, curbs, pitch pockets and supports as required by detail specifications. Project work will only be performed in areas to receive roofing system the same day.
- 10.2 In areas where abandoned projections will be removed the insulation system will be mechanically fastened to the new steel and/or aluminum decking using fastener spacing referenced above in section 9.5.
- 10.3 Apply a layer of 1/4" inch Dens-Deck Prime insulation to the flat and tapered insulation system mechanically attached to the metal and plywood decks. Insulation will be manufactured by Georgia-Pacific Corporation. Insulation will be adhered to the tapered insulation system in a solid application of I.S.O. Stick Adhesive applied 4 inches on center.

10.4 Application:

On tapered insulation system all layers of insulation will be installed in a solid application of I.S.O. Stick Adhesive. Review the roofing insulation plan. Gypsum insulation boards cannot be larger than 4 feet x 4 feet. Multiple layers of boards should use the staggered joint method of application.

A. Product Installation:

1. Using PaceCart 2:
 - a. Install Part 1 and Part 2 components following instruction on Bag-in-Box package.
 - b. Open flow valves on the dispenser completely and turn machine on. This allows adhesive to be pumped at a 1:1 ratio through the disposable mix tip and onto the substrate in a semi-liquid state.
 - c. Apply fluid mixture in $\frac{3}{4}$ to 1 inch wide wet beads spaced maximum of 4 inches on center that spreads in excess of 2 inches wide while rising $\frac{3}{4}$ to 1 inch.
 - d. Lay insulation board into place and walk-in to assure complete adhesion. Curing typically occurs in 4 to 8 minutes depending on temperature and weather conditions.
 - e. Check with roof system manufacturer for project specific spacing requirements.

3. Typical Application Rates:

Application rates vary depending on surface roughness and absorption rate of the substrate. Typical coverage rates for I.S.O. Stick Adhesive dispensed through the PaceCart 2 are 10-20 squares per 10 gallon Bag-in-Box sets. Typical coverage rates for I.S.O. Stick Adhesive dispensed through SpotShot applicators is 4-6 squares per case (4 sets of 1500 ml cartridges). All coverage rates are based on 12 inch on center maximum spacing. See chart below for typical application rates on specific substrates.

Application Rates (Bag-in-Box Dispensed from PaceCart2)	Typical Coverage Squares/Gallon
Insulation to Concrete	1.7 to 2
Insulation to Insulation	1.7 to 2
Insulation to Smooth Bur	1.5 to 1.7
Insulation to Modified Bitumen	1.5 to 1.7
Insulation to Gypsum	1 to 1.2
Insulation to Lightweight Concrete*	1 to 1.7
Insulation to Wood	1.7 to 2
Insulation to Cementitious Wood Fiber	1 to 1.2
Insulation to Steel	1 to 1.2

4. Reaction Time:

It is important to monitor the speed of the reaction in relation to the temperature (substrate and ambient) at time of application to ensure a complete reaction. Note the charts below for correct ‘Part 2’ component selection:

Typical Reaction Time Characteristics

a. 5 Gallon Bag-in-Box Packaging

Temperature	Part 2 Formula	Tack Free Time (minutes)	Set Up Time (minutes)
40°F+	R	3-5	10-12

b. 1500 ml SpotShot Cartridges

Temperature	Part 2 Formula	Tack Free Time (minutes)	Set Up Time (minutes)
0°F-40°F	W	3-4	10-12
40°F+	R	3-5	10-12

Important: When applying I.S.O. Stick Adhesive, board stock must be placed into the adhesive shortly after it has reached its maximum rise while it is still wet and tacky and before it reaches its tack free state.

- 10.5 Install no more insulation than can be covered with new roofing membrane the same day. No phased construction of roofing membrane is acceptable.
- 10.6 Insulation panels will have joints staggered. Joints in upper layers of insulation will be a minimum of 6 inches away from joints in the lower layers of insulation. Gaps between panels of insulation will not exceed 1/8 inch at wood blocking and joints in the field of insulation will be tight. Panels with broken corners, damaged facers or wet panels of insulation will not be used.
- 10.7 Dens-Deck Prime coverboard will be primed in the field with an approved quick drying asphalt primer.
- 10.8 Plastic shipping wrappings on insulation will be removed at time of site delivery and insulation will be covered with tarpaulins.
- 10.9 Due to thickness of insulation, insulation panels will need to be pressed in place and cut to contour of roof area.

11.0 ROOFING SYSTEM:

- 11.1 The surface of the insulation shall be clean and free of debris.

- 11.2 Apply two (2) layers of Type VI fiberglass felts into the No-Smell Type IV Hot Asphalt by Continental Materials Inc., at approximately 26 lbs., per 100 square feet, over the newly installed insulation.
- 11.3 Use 12 inch and 24 inch wide plies to start and finish roof membrane along roof edges and termination's.
- 11.4 The properly heated Type IV asphalt (ASTM D-312) should be poured from a suitable container or applied with a mop just ahead of the membrane to form a pool of bitumen into which the membrane will be rolled. Asphalt must be mopped so as to extend beyond both edges of the sheet. The roll of membrane should push a puddle of asphalt ahead of it with no voids. Care should be taken not to induce stretch into the membrane. Care should also be taken not to trap air under the membrane. The amount of asphalt should be sufficient for excess asphalt to squeeze out along the edges of the membrane, approximately 30 pounds per 100 square feet. Repeat the procedure with the other half of the strip.
- 11.5 Extend all plies above the top edge of cant strips along the bases of parapets, gravel stops, walls, and projections. Air Seals at blocking will be required where positive air pressure exists. Seals will be formed with approved Sealant, Closed Cell joint backing or a combination of materials.
- 11.6 Felts will be broomed into place during hot application. Brooming will be done from the side and foot traffic will not be allowed over freshly applied plies.
- 11.7 Immediately following the application of the Type VI felts, install one ply of the Firestone SBS Premium FR Cap into the Type IV Hot Asphalt at approximately 26 lbs., per 100 square feet.
- 11.8 Lap seams in the base ply should not coincide with the laps of the cap sheet. The courses should be staggered to ensure this.
- 11.9 Each ply shall be pressed (broom or squeegee) into place to assure total adhesion and that the ply is free of air pockets, wrinkles, fishmouths, or open laps.
- 11.10 The total membrane system must be completed at one time. Phase construction is not permitted unless otherwise directed by the Manufacturer.
- 11.11 At the end of each day's work, install water cut-offs anywhere moisture could enter the assembly. Remove cut-off before resuming work.

- 11.12 When flashings are not immediately installed, strip edge of membrane to seal out moisture.
- 11.13 At all intersections of the plane of the roof, walls, curbs or other raised edges, install cant or tapered edge strips. Extend roofing felts to the top of the cant but not more than two (2) inches above. At flat or raised edges, extend felts to the edge of the building, installing a felt envelope as required.

12.0 TEMPORARY FLASHING:

12.1 All cants and related components shall be in place.

12.2 One (1) Ply of approved waterproof felt will be:

12.2a install temporary flashing a minimum of 4 inches out beyond components and up a minimum of 4 inches beyond top edge of components and cants in approved asphalt at 30 pounds per 100 square feet per ply per mopping.

or

12.2b install temporary flashing a minimum of 6 inches out beyond component and up a minimum of 4 inches beyond top edge of components and cants in asphalt mastic at 3/4 pounds per foot per ply.

12.3 No voids will be left in temporary flashing application. Applicator may use additional protection for inclement weather. All damage to temporary flashings will be corrected before roof membrane is installed.

13.0 ENVELOPE WATERSTOP

13.1 All work related to the termination point of the insulation will be completed before insulation is placed.

13.2 An approved coated base sheet will be:

13.2a install waterstop a minimum of 6 inches under the face edge of insulation and wrapped up face and back a minimum of 6 inches from the face in approved asphalt

at 30 pounds per 100 square feet, top dress waterstop with approved asphalt.

Or

- 13.2b install waterstop a minimum of 6 inches under face edge of insulation and wrapped up face and back a minimum of 6 inches from the face in asphalt mastic at 3/4 pound per feet, top dress waterstop with asphalt mastic.
- 13.3 No voids will be left in waterstop application. Applicator may use additional protection for inclement weather. All damage to waterstop will be corrected before roof membrane is installed.

WATERSTOP is formed when all plies of Roof Membrane are extended over the turned edge of the envelope.

14.0 METAL COPING CAP, PERMA-TITE GOLD, Drawing Letters A-A, A1-A1, B-B & C-C Details #D-WL-570, #D-WL-571, #D-WL-572 & #D-WL-575:

- 14.1 Existing metal coping caps and flashings will be removed. Existing wood blocking will be replaced. New blocking will be Grade "A" lumber fastened to the top of the wall with two rows of approved fasteners spaced every 18 inches on center, staggered pattern. One fastener will be located within 2 inches of the blocking ends.
- 14.2 The wall/cant juncture will be examined for air passage. If air flow is present, joint between cant and wall will be sealed with closed cell joint backing and reglet joint sealant.

Note: For Detail Letters A1-A1 & B-B - At the base of the wall, install 1/2" CDX Plywood. Secure the plywood to the concrete wall with approved fasteners spaced every 12 inches on center, staggered pattern. Insulation will butt up tightly to the plywood. A fiber cant will be installed.

- 14.3 Walls will then be primed with asphalt quick drying primer applied at the rate of 1 gallon per every 100 square feet. Allow primer to dry.
- 14.4 All plies of Roof Membrane will be installed and will extend 2 inches over top of fiber cant.
- 14.5 Over the top of the roofing felts, install one (1) ply of approved Base Flashing Membrane, fully adhered to the wall and wood blocking extending four (4) inches

- beyond the base of the cant and up the face of the cant across the top of the wood blocking. Flashing will be nailed off every 8" on center with approved fasteners.
- 14.6 Over the base ply of Flashing Membrane, install a second ply of approved mineral surface Flashing Membrane, fully adhered in the same manner as the first ply. It shall extend six (6) inches beyond the base of the cant and up the wall to the same height as the base ply of flashing membrane. Laps of flashings will be 4 inches.
- 14.7 Laps of flashings will be 4 inches. Cold applied flashings will require 3 coarse application and mesh and Silver Flash mastic.
- 14.8 Over the top of the wall, install a new 0.050 Aluminum Perma-Tite Gold Metal Coping System by Metal Era. Color will be selected by the State.

All corners, end caps, etc., will be fabricated by Metal Era. No shop-fabricated metal will be allowed on the perimeter of the roofs. Outside and inside fascia dimensions are noted below.

Inside Fascia = 4.0"
Outside Fascia = 7.0"
Width of Existing Wall = Varies See Drawing

14.9 Coping Installation Instructions:

Step 1 – Corner support clips:

- a. Locate and fasten galvanized corner support clips to the wall.

Step 2 – Miter splice plates & anchor clips:

- a. Position the splice plate in the center of the anchor clip. Install the splice plate and anchor clip assembly halfway into each end of the corner as shown.

Step 3 – Miter:

- a. Place the corner assembly into position and secure at the exposed edge of the anchor clips as per manufacturer's detail A.

Step 4 – Endcap Anchor Clips:

- a. Locate and fasten galvanized anchor clips to wall with provided fasteners for substrate (see detail A).

Step 5 – Endcap splice plates:

- a. Remove release paper from top of factory applied sealant strips. Place splice plate onto second anchor clip as shown.

Step 6 – Endcap:

- a. Hook outside face of endcap over the anchor clips and rotate into place. Engage rear leg onto anchor clips by pressing downward until snap lock occurs.

Step 7 – Anchor clips:

- a. Locate over membrane and fasten galvanized anchor clips to wall at 3'-0" (914 mm) center with provided fasteners as shown in detail A.

Step 8 – Splice plates:

- a. Place splice plate onto anchor clips at splice joints, 12'-0" (3.65 m) O.C. Note: Remove release paper from sealant strips.

Step 9 – Coping:

- a. Hook outside face of coping over the anchor clips and rotate into place. Engage rear leg onto anchor clips by pressing downward until snap lock occurs.

Step 10 – Completion:

- a. Continue installing coping with a 3/8" (10 mm) space at splice joints to allow for thermal expansion. Field cut where necessary using fine tooth hacksaw or snips. Note: Remove protective film immediately.

14.10 Installation Notes:

- a) Installing contractor shall check as-built conditions, including nailer attachment, and verify the manufacturer's coping details for accuracy to fit the wall assembly prior to fabrication.

b) Fasteners must be corrosion resistant and rated for a minimum 250# pullout force for the substrate that is being used.

c) **Remove protective film immediately.**

15.0 EXPANSION JOINT, Drawing Letter I-I, Detail #D-EX-640:

- 15.1 New expansion joints will be installed at the existing locations. Existing expansion joints and wood blocking will be removed.
- 15.2 Vertical Grade "A" wood will provide a minimum 8" rise above the finished roof surfaces. Wood on both sides of the joint must be equal in height so expansion joint is level. Horizontal wood blocking will be installed the will match the height of the tapered insulation and crickets. Blocking will be Grade "A" lumber and will be secured to the deck with two rows of approved fasteners spaced every 18 inches on center, staggered pattern. One fastener will be located within one inch of the blocking ends. At each location, a split treated 4 inch x 4 inch wood cant will be nailed in place. Before torch application begins, all wood surfaces will be covered one (1) ply of the self-adhered base sheet as described below in Section 32.0.
- 15.3 The roofing base plies shall be fully adhered in place and shall terminate not more than two inches above the wood cant.
- 15.4 Flashing shall be accomplished using one ply of SBS Base flashing membrane and one ply of SBS Granular Cap modified mineral surfaced flashing membrane fully adhered in asphalt or mastic. The base ply membrane shall be installed from a point 2 inches from the base of the cant and extend to the top of the wood blocking.
- 15.5 The surface flashing sheet shall then be installed from a point 4 inches from the base of the cant and extend to the top of the wood blocking.
- 15.6 Lap seams in the lower flashing layer shall never coincide with the laps of the upper flashing layer. Both flashing membranes shall be adhered in place and mechanically attached to the top edge of the wood blocking. Cold applied flashings will required 3 coarse application and mesh and mastic.
- 15.7 Along top edge of the completed flashing membrane system, mechanically attach, eight (8) inches on center, both flashing plies with manufacturers approved fasteners.

- 15.8 All flashing sheets shall be cut off the end of the roll and be applied vertically, always working to a selvage edge.
- 15.9 The void between sides of expansion joint curbs will be filled with compressible fibrous glass insulation installed using an EPDM sling to keep the insulation in place.
- 15.10 A new .050 Aluminum Expansion Joint Cap, mill finish, will be installed on over the joint. Aluminum Cap will extend a minimum of 2 inches over Flashing. Cap sections will not exceed 10 feet splice plate will be a minimum of 6" wide at each joint.
- 15.11 Expansion joint cover will be attached to wood curb with stainless steel fasteners spaced every 12.0" on center. Fasteners will have neoprene washers.
- 15.12 Expansion Joint Curbing will extend to perimeter of roof area. Metal Cap and End Termination will extend down over gravel stop or up and under counterflashing at abutment walls.

16.0 METAL FLANGED UNITS, (Detail #D-MF-600):

- 16.1 New Grade "A" wood blocking will installed. Wood blocking will be fastened to the deck with two rows of approved fasteners spaced every 12 inches on center, staggered pattern. One fastener will be within one inch of the blocking end. New blocking will be installed so flange is even or slightly above finished roofing system.
- 16.2 All plies of Roof Membrane will extend over the wood blocking. Approved mastic will be applied to blocking under flange location at the rate of 1/2 pound per foot. Metal Curb will be set into place and secured with screws penetrating blocking at least 1 1/2 inches.
- 16.3 The horizontal flange of metal curb will be flashed using the SBS Base ply membrane and SBS Granular modified mineral surfaced. The base ply sheet shall be lapped a minimum of three (3) inches to itself and shall extend a minimum of three (3) inches onto the base roofing ply and up on the horizontal surface of the flange.
- 16.4 The SBS Granular modified mineral surfaced flashing sheet shall be lapped a minimum of three (3) inches onto itself and shall extend a minimum of four (4) inches onto the roofing surface ply and up on the horizontal surface of the flange.

- 16.5 Lap seams in the base layers shall never coincide with the laps of the modified mineral surfaced membrane.
- 16.6 The top edge of Flashing Membrane at vertical rise of curb will be sealed with a 1 inch x 1 inch bead of a Neoprene-Based Sealant tooled off to form a watershed.

17.0 METAL CURB FLASHING, (Detail #D-MC-604):

- 17.1 New wood blocking will be installed at locations to receive new curbs. Wood blocking will be Grade "A" lumber and will meet or slightly exceed the height of the tapered insulation. Blocking will be secured to decking with two rows of approved fasteners spaced every 18 inches on center, staggered pattern. One fastener will be located within one inch of the blocking ends.
- 17.2 All plies of Roof Membrane will extend up 2 inches over the top of the cant.
- 17.3 Curbs will have covers removed. Flashing will be installed 1/2 inch below upper surface of metal curb and will extend a minimum 6 inches onto the horizontal membrane surface. Flashing will be installed in a solid application of approved mastic.
- 17.4 Over the top of the roofing felts install one (1) ply of SBS Base flashing membrane, fully adhered with asphalt mastic extending two inches beyond the base of the cant strip and up the face of the curb to a point 1/2 inch from the top.
- 17.5 Over the base ply install one (1) ply of SBS Granular Modified Mineral Surfaced Flashing Membrane, fully adhered in the same manner as the base ply. It shall extend four (4) inches beyond the base of the cant and up the blocking to the same location as the base ply.
- 17.6 Laps of flashings will be 4 inches. Along the top edge of the completed flashing membrane system, mechanically attach, eight (8) inches on center, all flashing plies with manufacturers approved fasteners. Cold applied flashings will required 3 coarse application and mesh and mastic.
- 17.7 On all curbs install a 4 inch, 0.040 aluminum extender from under the frame over the new flashing. Fasten extender to curbing every 8" on center. On large units, a face mounted counterflashing will be installed under the unit. Counterflashing will be mechanically fastened in place every 8 inches on center. Fasteners will have neoprene washer and top edge of flashing will be caulked with General Purpose Sealant, tooled in place to present a neat, clean appearance.

- 17.8 Asphalt tape will be applied between flashing and metal curb. A termination bar with slotted holes and caulking cup will be installed at top edge of flashing fastened 8 inches on center.
- 17.9 Termination bar and metal will be cleaned of all dirt and materials. Bar and metal curb at caulking location will be wiped clean with approved cleaner and primed. Bar will receive a bead of General Purpose Sealant tooled in place.
- 17.10 Re-fasten metal caps or equipment.

18.0 ULTRA-FLASH FLASHING SYSTEM AT STUB UP POST SUPPORTS FOR DUCTWORK (Detail #D-UF-650):

- 18.1 At locations where 3 ½” Stub Up Post Supports for the ductwork are mounted to the roof deck. Wood blocking will be installed around perimeter of the Stub Up Post Supports to match thickness of the new insulation. The polyisocyanurate insulation will butt up tightly to the wood blocking installed around the Stub Up Post Support.
- 18.2 Grade “A” wood blocking will be secured to the deck with approved fasteners spaced every 18 inches on center, staggered pattern. One (1) fastener will be located within two inches of the blocking ends.
- 18.3 Over the wood blocking install a layer of ½” CDX plywood with a hole to allow for the Stub Up Post Supports. Plywood will butt up tightly to the Stub Up Post Supports and completely cover the wood blocking. Plywood will be fastened to the wood blocking with spiral shanked nails spaced every 8 inches on center.
- 18.4 Roofing system will be installed and will butt up against the Stub Up Post Supports.
- 18.5 Over the SBS Premium FR Cap, install the Ultra-Flash system that will extend up the vertical surface of the Stub Up Post Supports a minimum of 8 inches and a minimum of 8 inches onto the horizontal roof surface. Ultra-Flash system will completely cover the 3 ½” Stub Up Post Supports.
- 18.6 Ultra-Flash Flashing Application:
 - A. Climatic Conditions:
 - 1. Keep temperature of Ultra-Flash between 65°-85°F (18°-29°C) 24 hours before use.

2. Do not store in direct sunlight or temperatures about 90°F (32°C).
3. Do not apply Ultra-Flash under 40°F (4°C) or over 100°F (37°C).

B. Surface Preparation:

1. All surfaces to receive the Ultra-Flash system must be clean, dry and free of any dirt, dust, debris, rust and oils.
2. Any surfaces with oil or grease must be properly prepared with a suitable solvent based cleaner.
3. All metal surfaces must be abraded before application of the Ultra-Flash system to remove any existing rust or paint.
4. Mask off any areas not intended to receive the Ultra-Flash system with tape.
5. Wipe all metal surfaces with isopropyl alcohol to clean and prime the surface for the Ultra-Flash system.
6. Adhesion test may be required to determine system adhesion.

C. For Liquid Flashing Detail(s):

1. Once the preparation for the Ultra-Flash system is complete, apply a base coat of Ultra-Flash at a rate of 2.0 gal./sq. (32 wet mils) onto the horizontal and vertical surface extending the base coat to the edges of the taped off area.
2. Embed the Grip Polyester® Firm into the Ultra-Flash base coat, making the scrim 2" smaller than the applied base coat on all edges.
3. Apply a top coat Ultra-Flash at a rate of 5-6 gal./100 gal./sq. (48-64 wet mils) onto the horizontal and vertical surface extending the top coat to the edges of the taped off area.

Note: Make sure that none of the Grip Polyester Firm is exposed to the elements and completely covered by the Ultra-Flash.

19.0 RAIL CURBS, (Detail #D-RC-606):

- 19.1 Existing rail curbs will remain in place.
- 19.2 Edge of insulation will be chamfered to the slope of the cant. All plies of Roof Membrane will extend up 2 inches over the top of the metal cant.
- 19.3 Over the top of the roofing felts install (1) ply of SBS Base flashing membrane, fully adhered with asphalt mastic extending two inches beyond the base of the cant strip and up the face of the curb to a point 1/2 inch from the top.
- 19.4 Over the base ply install one (1) ply of SBS Granular Modified Mineral Surfaced Flashing Membrane, fully adhered in the same manner as the base ply. It shall extend four (4) inches beyond the base of the cant and up the blocking to the same location as the base ply.
- 19.5 Laps of flashings will be 4 inches. Flashings will required 3 coarse application and mesh and approved mastic. Along the top edge of the completed flashing membrane system, mechanically attach, eight (8) inches on center, all flashing plies with manufacturers approved fasteners and metal termination bars.
- 19.6 On all curbs install a 4 inch, 0.040 aluminum extender from under the frame over the new flashing. Fasten extender to curbing every 8" on center. On large units, a face mounted counterflashing will be installed under the unit. Counterflashing will be mechanically fastened in place every 8 inches on center. Fasteners will have neoprene washer and top edge of flashing will be caulked with General Purpose Sealant, tooled in place to present a neat, clean appearance.
- 19.7 Asphalt tape will be applied between flashing and metal curb. A termination bar with slotted holes and caulking cup will be installed at top edge of flashing fastened 8 inches on center.
- 19.8 Termination bar and metal will be cleaned of all dirt and materials. Bar and metal curb at caulking location will be wiped clean with approved cleaner and primed. Bar will receive a bead of General Purpose Sealant tooled in place.

**20.0 CONCRETE COLUMN FLASHING – ROOF AREAS 3 & 4,
Detail #D-CC-605:**

- 20.1 Concrete column flashing locations will require the removal of the existing flashing material. A fiber cant will be installed at the base of the column.
- 20.2 The cant juncture will be examined for air passage. If airflow is present, joint between cant and wall will be sealed with closed cell joint backing and approved general purpose sealant.
- 20.3 Over the top of the roofing felts, install one (1) ply of SBS Base flashing membrane fully adhered in an approved flashing grade Mastic or hot asphalt, extending 4 inches beyond the base cant up to the top of the concrete column.
- 20.4 Over the base ply install one (1) ply of SBS Granular Modified Mineral Surfaced Flashing Membrane, fully adhered in the same manner as the base ply. It shall extend six (6) inches beyond the base of the cant and up the wall to the same height as the base ply.
- 20.5 Laps of flashings will be 4 inches and require 3 coarse application and mesh and Approved Mastic.
- 20.6 The top edge of the flashing system will be secured to the concrete column with a metal termination bar. Termination bar will be secured every 6.0 inches on center with approved fasteners. A bead of Water Cut-Off Mastic will be installed between the upper edge of the flashing plies and concrete column. Water Cut-Off Mastic will be kept under constant compression.
- 20.7 After installation of the new flashing system the concrete columns will be capped. New column caps will be fabricated from 0.050 aluminum and will be a color selected by the State. Caps will cover the exposed flashing membrane by at least 4.0 inches. Column caps will be mechanically fastened to the masonry wall every 6 inches on center with approved fasteners. Fasteners will have neoprene washers.

**21.0 ULTRA-FLASH FLASHING SYSTEM AT PENETRATIONS THROUGH
VERTICAL FLASHING, (Detail #D-UF-655):**

- 21.1 Locations where the wall flashing membrane has penetrations (i.e. existing ground posts & new sleeve parapet penetrations for the chiller pipes) will be flashed with the Ultra-Flash Liquid Applied Flashing system as described.

- 21.2 The existing ground posts through the vertical flashings will have the existing flashing material removed.
- 21.2 Locations where new sleeve parapet penetrations for chiller pipes will be installed will also be flashed with the Ultra-Flash as described down below.
- 21.3 After the new two-ply flashing system is installed on the wall, the ground posts and new sleeve parapet penetrations will be flashed with the Ultra-Flash System.
- 21.4 Ultra-Flash Flashing Application:
- A. Climatic Conditions:
1. Keep temperature of Ultra-Flash between 65°-85°F (18°-29°C) 24 hours before use.
 2. Do not store in direct sunlight or temperatures about 90°F (32°C).
 3. Do not apply Ultra-Flash under 40°F (4°C) or over 100°F (37°C).
- B. Surface Preparation:
1. All surfaces to receive the Ultra-Flash system must be clean, dry and free of any dirt, dust, debris, rust and oils.
 2. Any surfaces with oil or grease must be properly prepared with a suitable solvent based cleaner.
 3. All metal surfaces must be abraded before application of the Ultra-Flash system to remove any existing rust or paint.
 4. Mask off any areas not intended to receive the Ultra-Flash system with tape.
 5. Wipe all metal surfaces with isopropyl alcohol to clean and prime the surface for the Ultra-Flash system.
 6. Adhesion test may be required to determine system adhesion.

- C. For Liquid Flashing Detail(s):
1. Once the preparation for the Ultra-Flash system is complete, apply a base coat of Ultra-Flash at a rate of 2.0 gal./sq. (32 wet mils) onto the horizontal and vertical surface extending the base coat to the edges of the taped off area.
 2. Embed the Grip Polyester® Firm into the Ultra-Flash base coat, making the scrim 2” smaller than the applied base coat on all edges.
 3. Apply a top coat Ultra-Flash at a rate of 5-6 gal./100 gal./sq. (48-64 wet mils) onto the horizontal and vertical surface extending the top coat to the edges of the taped off area.

Note: Make sure that none of the Grip Polyester Firm is exposed to the elements and completely covered by the Ultra-Flash.

4. Ultra-Flash system will extend a minimum of 4 inches onto the ground post / new sleeve parapet penetrations and 4 inches onto the vertical flashing.

22.0 PITCH POCKET, (Detail #D-PP-700):

- 22.1 Existing pourable pockets will be removed. Penetration will be cleaned of all existing pourable sealer.
- 22.2 New wood blocking will be installed around the penetration that will meet or slightly exceed the height of the new insulation. Blocking will be Grade “A” lumber and will be fastened through the base sheet to the decking with two rows of approved fasteners spaced every 6 inches on center, staggered pattern.
- 22.3 Insulation will butt up tightly to the wood blocking.
- 22.4 Roofing system will extend across wood blocking to the inside edge of the blocking.
- 22.5 Opening between blocking and penetration will be filled with non-shrinking grout.

- 22.6 Pitch pocket metal will be soldered or welded to be watertight. 16 ounce copper or stainless steel are acceptable metals. The pocket will have a four inch (4") flange that will be set in a solid bed of Firestone Multi-Purpose MB Flashing Cement placed over the field plies. Pocket will be fastened to the blocking with approved spiral shanked nails. Surface of flange will be primed with Quick Drying Asphalt Primer.
- 22.7 Bottom of pocket will be filled with non-shrinking grout. Over the grout, fill the pocket with Firestone Pourable Sealer that will have a minimum coverage of 2 inches around the penetration.
- 22.8 Flange will be flashed with one-ply of the approved interply flashing membrane that will extend from the base of the pocket to a point 3 inches on the roofing surface. Interply flashing will be covered with one-ply of the modified mineral surfaced flashing ply that will extend from the base of the pocket to a point 6 inches onto the roofing membrane. Inside edge of flashing system, at the base of the pocket, will be sealed with a full bead of Multi-Purpose MB Flashing Cement.
- 23.0 ROUND VENT / INSULATED PIPE / HEAT STACK FLASHING,
(Detail #D-RV-760):**
- 23.1 Grade "A" wood blocking will be installed. Additional wood blocking providing 1 inch of increased height will be secured.
- 23.2 Tapered edge strip will be used for transition to insulation surface. Tapered edge strip will be installed in continuous spreads of approved adhesive. All plies of Roof Membrane will extend over blocking.
- 23.3 Asphalt mastic will be trowel applied on wood blocking. Metal Curb flange will be set in place and secured to blocking with screws 8 inch on center. Horizontal flange of metal curb will be flashed with the base ply and surface ply flashing membranes set in asphalt mastic. Application rate will be 3/4 pound under and 3/4 pound over the base ply flashing per foot.
- 23.4 Metal Hood will be installed. Metal Hood will provide a 1/2 inch flange collar for soldering or clamping and will extend at least 2 inches over vertical rise portion of curb. Metal Hood will be fabricated from 0.040 aluminum or heavier gauge steel.
- 23.5 Where clamping ring is used, asphalt tape will be used as gasket and a General Purpose Sealant will be applied in bead 1/2 inch x 1/2 inch at joint between clamping ring and stack.

24.0 SOIL STACK DETAIL, (Detail #D-SS-780)

- 24.1 Plumbing pipes will be flashed with 4 pound lead flashings. Horizontal flanges will extend a minimum of 4 inches onto the horizontal roof mat.
- 24.2 The roofing ply sheets will extend to intersection of roof and soil stack.
- 24.3 Lead horizontal flanges will be primed and placed in a solid bed of asphalt mastic.
- 24.4 Lead will be crimped into pipe at least 2 inches and for pipes 2 inches or less in diameter, lead top caps will be required.
- 24.5 Lead flanges will be covered with the flashing base, which shall extend past edges of lead flange a minimum of two (2) inches.
- 24.6 The base flashing ply and the lead flange will then be covered with the surface flashing ply. The surface ply will be cut to fit tightly around base of lead flange. The surface flashing will extend past edges of the lead flange by 4 inches.
- 24.7 The edge of the roofing membrane at the vertical rise of the lead will be sealed with a 1 inch x 1 inch bead of a Neoprene-Based Sealant tooled off to form a watershed.

25.0 PROCURB FOAM PIPE SUPPORTS, Detail #D-FS-858:

- 25.1 New Foam Pipe Supports will be installed underneath new mechanical exterior piping on the west side of roof areas 4 and 1 and up the middle of roof area 1.
- 25.2 The piping will be attached to foam supports as directed by the manufacturer every 5 feet on center. A walkpad or additional piece mineral surface modified membrane will be cut to be placed under the pipe support.

26.0 DRAINS, (Detail #D-DR-800):

- 26.1 Existing drains and downspouts will be replaced. New drains will be Smith Model 1310 or equal. Sizes of new drains will match existing. Drains will have deck clamps and threaded receivers. No-Hub connections are also acceptable.
- 26.2 Drains will have a minimum 4 foot by 4 foot sump. Drains will not hold water at the collar.

- 26.3 All plies of the Roof Membrane will extend into the drain. Drains will be plugged to prevent clogging from gravel, dirt or debris. **PLUGS WILL BE REMOVED EACH DAY TO INSURE PROPER DRAINAGE.**
- 26.4 Four (4) pound lead a minimum of 30 inches X 30 inches will be installed in drains. Lead will be placed in trowel application of asphalt mastic. Lead will be formed into drain bowl. Lead will be secured under clamping collar and edge of lead will be flashed with 12 inch mesh membrane based and top dressed in Asphalt Mastic. Application rate of mastic will be 1 pound under and 1 pound over mesh per foot.
- 26.5 New metal domes will be installed on drains to prevent debris from plugging pipes each day drains are treated.
- 26.6 Drain sumping and installation of roof membrane and lead must be performed as an integral part of roofing process. Secondary applications of drain details must be approved by State's Project Manager.
- 26.7 Installation of new drains and piping must be performed by a State approved Plumbing or Mechanical Contractor.
- 26.8 A pre-construction and post construction drain inspection will be made by the Contractor and the State Project Manager. Any drains clogged before work begins will be opened by the State. The Contractor will be responsible to open any clogged drains found during work or at the completion of the project.
- 27.0 THROUGH-WALL SCUPPERS & DOWNSPOUTS / ROOF AREAS 3 & 4, (Details #D-SC-810 & #D-DS-825):**
- 27.1 New scupper boxes and downspouts will be installed at existing locations.
- 27.2 Wood blocking will be installed against the wall at the scupper location. Height of blocking will be less than the height of the insulation. A sump will be created around the scupper box. Cants will be tapered to scupper location. Scupper will not hold water at flashing location.
- 27.3 The base layers of roofing will be installed over the Dens-Deck Prime insulation and will terminate at outside edge of scupper location.
- 27.4 New 0.050 aluminum flange will be installed from inside the new 0.050 aluminum scupper box to a point four inches onto the roofs surface. Bottom

- flange will be set in a solid application of asphalt mastic and will be fastened to the wood blocking with two rows of approved fasteners.
- 27.5 Upper flange will extend from inside the scupper box, through the scupper location and up the vertical wall at least six inches. Flange will be secured to the masonry or wood wall with approved fasteners spaced not more than three inches on center.
- 27.6 A base stripping ply will be installed over the lower flange from a point just inside the scupper box to at least three inches past the inside lip of the flange.
- 27.7 Over the stripping ply, install the Mineral surfaced flashing ply that will extend from within the scupper box past the edge of the stripping ply at least two inches.
- 27.8 The surface roofing sheet will then be install overlapping the outside edge of the flashing by at least two inches. All laps will be made so not to buck water in any way.
- 27.9 The upper flange will be primed with approved primer. The surfaced flashing ply will extend from under the new metal edge and overlap the upper flange by at least four inches.
- 27.10 Outside edge of upper scupper box termination will be sealed with a full bead of approved sealant tooled in place to form a watershed.
- 27.11 New scupper boxes will be fabricated from 0.050 aluminum and will be a color selected by the State. Sizes of scupper boxes will match existing.
- 27.12 New 0.050 downspouts will be installed. Downspouts will be 6 inch by 6 inch and color will be selected by the State.
- 27.13 Due to the new HVAC equipment there is one new downspout on the west side of roof area 4 that shall be installed in order to redirect the water and tied in with the next downspout on the south side of Roof Area 4 to discharge the water to the ground.
- 27.14 Downspouts will be secured to the masonry walls with approved fasteners every 3.0 feet on center and sloped to allow for a minimum 1/4-inch rise in a 1-foot length. Downspouts will have a 45 degree elbow at the base. A concrete splash block will be placed at the base of the downspout as shown on the drawing.

28.0 WALKPADS, (Detail #D-WP-860):

28.1 Walkpads will be placed at the following locations:

- a. Around the roof hatch.
- b. Underneath Pavers located on Roof Area 1 and Southeast corner of Roof Area 4.
- c. Additional 300 lineal feet to locations to be designated by the State's Project Manager.

28.2 The area is to be dry and swept clean of dirt and debris. X-Tred Walkpads can be installed in spot applications of approved Plastic Cement.

28.3 Prior to application, the material should be cut in maximum four foot lengths and allowed to relax until flat. A straight edge or chalk line should be used to ensure straight, square cuts. Never cut material directly on the roof surface.

28.4 Walkpad should be positioned so as to leave a minimum two inch gap between panels, allowing for proper drainage.

28.5 Walkpad is adhered to the Surface roofing membrane using the approved Plastic Cement. Cement is applied to the back of the Walkpad in spots of approximately five (5) inches square in the pattern shown in the detail drawing.

28.6 Use a notched trowel to keep the cement 3/8" thick. "Walk in" each panel to ensure complete contact with the membrane surface.

29.0 PAVER DETAIL, Detail #D-PV-865:

29.1 Existing 16 inch by 16 inch concrete pavers will be re-installed at existing locations including:

1. Pavers that support Duct / Pipe stands.

29.2 Existing uni-struts will be cut in order to raise the paver to accommodate the height of the new roofing system. New angle clips will be installed to secure the uni-strut to the concrete paver.

29.3 Existing pipe supports will be cut in order to raise the height of the pavers. Existing pipe support bases will be re-used and will be secured to the concrete pavers with four fasteners per support.

- 29.4 The existing 2 foot by 2 foot pavers on Roof Areas 3 and 4 will be removed.
- 29.5 A walkpad will be installed between all concrete pavers and surface of the SBS modified roofing system. Walkpad must extend at least 2 inches past edges of concrete paver on all sides. Gaps between pavers will be 3 inches.

30.0 REPLACEMENT OF LIGHTNING PROTECTION, (Detail #D-LR-410):

30.1 Location:

- a. Existing lightning rods and cabling will be replaced. Contractor must ensure that cables are connected to existing grounding facilities within the building.
- b. Ground cabling on the vertical walls will be removed and then re-installed once the roofing system installation has occurred.

30.2 Installation must meet certification guidelines and must be installed by a certified lightning prevention contractor.

- Lightning Prevention Systems (856) 767-7209
- Paxson Lightning Rods, Inc. (610) 696-8290
- Warren Lightning Rod Company (856) 854-7000
- B & B Lightning Protection (609) 888-1929

30.3 New lightning rods will be the blunt tip design and made out of copper. Cables will be adhered to the roofing system in Universal Sealant.

30.4 Lightning rods and cables will be attached to the top of the new metal coping system with prefabricated bases set in approved universal sealant. Rods and cables **will not** be mechanically fastened to the metal copings.

31.0 INSTALLATION OF ROOF HATCH SAFETY RAILING:

31.1 A Babcock-Davis safety railing system with a side chain exit will be installed on the existing roof hatch located on Roof Area 1.

31.2 SAFETY RAILINGS:

- a. Top rail, Mid rail and upright posts: Galvanized Steel Pipe, 1 ¼" ID, A53 Grade B pipe.

- b. Exit: Self Closing Gate: Chain, link, galvanized steel
Fittings: Manufacturer's standard aluminum magnesium alloy, cast with set screw pipe mount.
- c. Fittings: Manufacturer's standard aluminum magnesium alloy, cast with set screw pipe mount.
- d. Counterflash Mount: CRS, zinc plated mounting bracket with backer plate, pemmed nut for easy installation.
- e. Hardware: Bolts and Tooling: 3/8 inch by 2-1/2 inch, grade Z, zinc plated, wrench for assembly.
- f. OSHA Compliance: Provide hatch safety railing system as required by OSHA Standard 1910.23 and 1910.27 and as specified.
 - 1. Top Rail Height: 42 inches +/-3" above finished roof deck.
 - 2. Top-Mid Rail Spacing: 21" diameter maximum.
 - 3. Meets 200lb deflection load when mounted to roof hatch counterflash.
 - 4. Upright post maximum spacing of 8'.
- g. Acceptable Product: Safety Railing for Roof Hatch, Model Number SRCG.

31.3 EXECUTION:

A. EXAMINATION

- 1. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper or timely completion.
- 2. Verify that deck, curbs, roof membrane, base flashing, and other items affecting Work of this Section are in place and positioned correctly.
- 3. Verify tolerances and correct improper conditions.
- 4. Do not proceed until unsatisfactory conditions have been corrected.

B. Installation

1. Install roof accessory items and components per manufacturer's instructions.
2. Coordinate installation of components of this Section with installation of roof deck, roof structure, roofing membrane, and base flashing.

C. ADJUSTING

1. Adjust movable parts for smooth operation.
2. Operational Units: Test-operate units with operable components, open/close gate.

D. CLEANING

1. Clean exposed surfaces per manufacturer's written instructions. Touch up damaged metal coatings.

32.0 INSTALLATION OF SELF-ADHERING MEMBRANE AT ALL LOCATIONS TO RECEIVE WOOD / ROOF AREAS 3 & 4, (PERIMETER & PROJECTION FLASHINGS):

- 32.1 For protection of wood that is not completely covered by the base sheet install one layer of Self-Adhering FR Base Sheet to all wood surfaces. Base Sheet will extend from a point three inches on the roof, up the wall and/or across the wood blocking to terminate at the top of any vertical blocking and below the bottom edge of any horizontal blocking.
- 32.2 Starting at a point three inches on the roofing system, unroll the self-adhering base sheet into the desired position. Fold the membrane length wise back onto itself, remove the split back release film from the exposed side and gradually push the membrane into place. Apply even pressure along the entire length of the membrane from the center to outer edges to avoid air pockets or wrinkles. Repeat for the other side. Firmly apply pressure with a suitable weighted roller to ensure 100% adhesion.
- 32.3 Position the next sheet overlapping the previous sheet by 4 inches. Firmly apply pressure with a suitable weighted roller to ensure 100% adhesion. Extend the plies down past the outer edge of the horizontal blocking and up and over the top of the vertical blocking.

33.0 CLEAN-UP:

- 33.1 Grounds around Building and rooftops will be cleaned of all paper and debris. Cleaning must meet the satisfaction of the State's Project Manager.
- 33.2 Dumpster will be covered at the end of each days work. Area around dumpster will be cleaned on a daily basis.
- 33.3 The finished roof system will be clean and free of any and all marks or spills. The State's Project Manager must approve the final appearance of the roofing project before the project is deemed complete.

34.0 ALTERNATE # 6A: COATING OF ROOFING AND FLASHINGS ON ROOF AREAS 3 & 4:

- 34.1 At the completion of the new roof installation coat the entire roof and flashing systems on Roof Areas 3 & 4 with two coats of AcryliTop PC-100 roof coating.
 - a. Install one (1) coat of Acrylic Base Coat for Asphalt at the application rate of one and a half (1 1/2) gallons per every 100 square feet per coat.
 - b. Install one (1) coat of AcryliTop PC-100 Top Coat at the application rate of one (1) gallon per every 100 square feet per coat.
 - c. Two and a half 2.5 gallons per every 100 square feet total.

35.0 ALTERNATE # 6B: COATING OF ROOFING AND FLASHINGS ON ROOF AREA 1:

- 35.1 At the completion of the new roof installation coat the entire roof and flashing systems on Roof Area 1 with two coats of AcryliTop PC-100 roof coating.
 - a. Install one (1) coat of Acrylic Base Coat for Asphalt at the application rate of one and a half (1 1/2) gallons per every 100 square feet per coat.
 - b. Install one (1) coat of AcryliTop PC-100 Top Coat at the application rate of one (1) gallon per every 100 square feet per coat.
 - c. Two and a half 2.5 gallons per every 100 square feet total.

**36.0 ALTERNATE # 6C: COATING OF ROOFING AND FLASHINGS ON
ROOF AREA 2:**

- 36.1 At the completion of the new roof installation coat the entire roof and flashing systems on Roof Area 2 with two coats of AcryliTop PC-100 roof coating.
- a. Install one (1) coat of Acrylic Base Coat for Asphalt at the application rate of one and a half (1 1/2) gallons per every 100 square feet per coat.
 - b. Install one (1) coat of AcryliTop PC-100 Top Coat at the application rate of one (1) gallon per every 100 square feet per coat.
 - c. Two and a half 2.5 gallons per every 100 square feet total.

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SPECIFICATIONS SECTION 077253
SNOW GUARDS – ROOF AREA 6:

PART 1 GENERAL

1.1 MATERIALS INCLUDES

- A. Snow Guards: Brackets, bars, clamps, bar caps, Ice stops, etc to supply a complete snow guard system. Finish: Polyester Powder Coated.

1.2 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. ASTM D 532 Gloss
 - 2. ASTM D 33363 Hardness
 - 3. ASTM D 3359 Adhesion
 - 4. ASTM D 522 Flexibility
 - 5. ASTM D 1308 Resistance to chemical and staining
 - 6. ASTM D 2794 Impact Resistance
 - 7. ASTM D 4060 Abrasion.

1.3 COMPONENTS

- A. Mounting Clamp: non penetrating technology PMC A-2 Ace Clamp complete with set countersunk set screws, polyester powder coated. .
- B. Mounting Bracket: pre drilled for double clamps and double bars with countersunk threaded set screws all polyester coated.
- C. Bar's: 1" diameter aluminum tubing in 8' lengths, polyester powder coated
- D. Coupler: threaded self expanding coupler the ID of the bars.

- E. Collars: Aluminum collar with recessed set screw polyester powder coated.
- F. Caps: Friction lock snap-in caps chrome plated.

1.4. DESIGN REQUIREMENTS

- A. Bracket spacing is determined by the width of the panels (18"). Number of compression clamps to be determined by the manufacturer.

1.3 SUBMITTALS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 of the specifications apply to this Section
- B. Product Data: Submit manufacturer current technical literature for each type of product.
- C. Samples: Provide nominal 3 x 5 inch sample of each color indicated for for the snow guard.
- D. Manufacturers detail drawings and recommended layout for the snow guard submitted.
- E. One of each of the components.
- F. Manufacturers detailed instructions for installing the snow guards

1.4. QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer shall have a minimum of five (5) years experience in the manufacturing and installation of snow guards.
- B. Fabricator Qualifications: Shall be approved by manufacturer for the installation of the submitted snow guard.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Material upon receipt is to be inspected for damage and completeness of order. All damaged material is to be returned and replacement parts ordered. Incomplete orders shall be reordered. If the schedule for replacement material will delay installation notify Architect, Owner and Roof Contractor.

1.6; WARRANTY

- A. Finish Warranty: All parts subject to exposure shall be powder coated or be stainless steel or anodized aluminum.
- B. Manufacturing Defects: Standard form in which manufacturer agrees to repair or replace items that fail by blistering, checks, crazes, flakes, peels or weathers unevenly due to a defect in manufacturing within warranty period from date of original installation.
- C. Warranty Period: 20 years.

PART 2 PRODUCTS

2.1 MANUFACTURER

- A. PMC Industries, Inc., P.O. Box 8028, 87 Spring Lane, Plainville, CT 06062

2.2 SUBSTITUTIONS

- A. Any manufacture that provides a snow guard system totally dependent on non penetrating attachment to the existing standing seam roof proposed in this specification with a minimum of 5 years experience, 20 year warranty and requires a licensed installer to install. The snow guard system must meet or exceed the standards of finishes, strength to block the snow and ice from sliding off the roof and provide a 20 year warranty.

2.3 SNOW GUARDS

- A. Materials:

1. A-2 Snow Bracket: extruded 6061-T aluminum with stainless steel fasteners a 6061-T6 plate to receive the tubing and to connect two non penetrating clamps to connect to the roof standing seams.
2. Tubing: 6061-T6 OD 1” and wall thickness 0.0125.
3. Tubing Couplers: 6061-T6 aluminum shaft with stainless steel washers and tightening bolts, nylon slip washers and rubber expansion washers.
4. Tubing caps are 302 Stainless steel.
5. Tubing Collars: 6061-T6 aluminum with stainless steel set screws.
6. Ice stops are 6061-T6 aluminum with stainless steel fasteners.

2.4 FINISH

A. Exterior Coating:

- 1.1. Aluminum 6061-T6 not anodized will be polyester powder coated :
- 1.2. Aluminum not coated shall be clear anodized.
- 1.3. Stainless steel polished

PART 3. EXECUTION

3.1. PREPARATION

- A. Verify that the roof system is complete and ready to receive the snow guard installation.
- B. Secure verification from the roof manufacture that the add load from the snow guards will not over load the roof attachments to the roof structure roof.

3.2. INSTALLATION

A. General:

- 1.1. Follow drawings and installation instructions supplied by the snow guard manufacturer

- 1.2. Do not install damaged components.

PART 4 CLEANING AND PROTECTION

4.1. INSPECT INSTALLATION AND SITE

- A. Remove damaged, defective or improperly installed materials. Replace with new materials installed per requirements and instructions supplied by the manufacturer.
- B. Clean finished surfaces according to manufacturer's written instructions; maintain clean condition until Final Completion.
- C. Remove all trash and debris from the site, building or where ever stored on site on daily before leaving the site and again a final clean up prior to Final Completion.

END OF SPECIFICATION SECTION

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SECTION 23 05 19
METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gages and pressure gage taps.
- B. Thermometers and thermometer wells.
- C. Static pressure gages.

1.02 RELATED REQUIREMENTS

- A. Section 23 21 13 - Hydronic Piping.

1.03 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments; 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers; 2014.
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers; 2014.
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.
- C. Project Record Documents: Record actual locations of components and instrumentation.
- D. Maintenance Materials: Furnish the following for State of Delaware OMB - Division of Facilities Management's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
 - 2. Extra Pressure Gages: One of each type and size.
 - 3. Extra Thermometers: One of each type and size.

1.05 FIELD CONDITIONS

- A. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.

PART 2 PRODUCTS

2.01 PRESSURE GAGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Moeller Instrument Company, Inc: www.moellerinstrument.com.
 - 3. Omega Engineering, Inc: www.omega.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Pressure Gages: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.

2.02 PRESSURE GAGE TAPPINGS

- A. Gage Cock: Tee or lever handle, brass for maximum 150 psi.

- B. Needle Valve: Brass, 1/4 inch NPT for minimum 150 psi.
- C. Pulsation Damper: Pressure snubber, brass with 1/4 inch connections.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Omega Engineering, Inc: www.omega.com.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Stem: 3/4 inch NPT brass.
 - 4. Accuracy: 2 percent, per ASTM E77.
 - 5. Calibration: Degrees F.

2.04 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.
- B. Flange: 3 inch outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.05 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

2.06 STATIC PRESSURE GAGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com.
 - 2. Omega Engineering, Inc: www.omega.com.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com.
 - 4. Substitutions: See Section 01 60 00 - Product Requirements.
- B. 4 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gage per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gage.
- C. Install pressure gages with pulsation dampers. Provide gage cock to isolate each gauge. Provide siphon on gages in steam systems. Extend nipples and siphons to allow clearance from insulation.
- D. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

- E. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- F. Install gages and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- G. Adjust gages and thermometers to final angle, clean windows and lenses, and calibrate to zero.

3.02 SCHEDULE

- A. Pressure Gages, Location and Scale Range:
 - 1. Pumps, 0 to 60 psi.
 - 2. Expansion tanks, 0 to 60 psi.
- B. Pressure Gage Tappings, Location:
 - 1. Major coils - inlets and outlets.
 - 2. Chiller - inlets and outlets.
 - 3. Boiler - inlets and outlets.
- C. Stem Type Thermometers, Location and Scale Range:
 - 1. Hot Water Headers to central equipment, 30 to 240 degrees F.
 - 2. Chilled Water Headers to central equipment, 0 to 120 degrees F.
 - 3. Hot Water Coil Banks - inlets and outlets, 30 to 240 degrees F.
 - 4. Chilled Water Coil Banks - inlets and outlets, 0 to 120 degrees F.
 - 5. Boilers - inlets and outlets, 30 to 240 degrees F.
 - 6. Chiller - inlets and outlets, 0 to 120 degrees F.
- D. Static Pressure and Filter Gages, Location and Scale Range:
 - 1. Built up filter banks, 0 to 3 inches W.C..
 - 2. Unitary filter sections, 0 to 3 inches W.C..
 - 3. Supply fan discharge, 0 to 10 inches W.C..

END OF SECTION

HVAC UPGRADES & ROOF REPLACEMENT
OMB/DFM CONTRACT NUMBERS
MJ1002000012 & MJ1002000008

DELAWARE STATE POLICE FIRING RANGE
OCTOBER 2018

METERS AND GAGES FOR HVAC PIPING
23 05 19-4

DEDC,LLC
16P008

SECTION 23 21 13
HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Chilled water piping, buried.
- D. Chilled water piping, above grade.
- E. Pipe and pipe fittings for:
 - 1. Heating water piping system.
 - 2. Chilled water piping system.
 - 3. Equipment drains and overflows.
- F. Pipe hangers and supports.
- G. Unions, flanges, mechanical couplings, and dielectric connections.
- H. Valves:
 - 1. Gate valves.
 - 2. Globe or angle valves.
 - 3. Ball valves.
 - 4. Manual Calibrated Balancing Valves
 - 5. Butterfly valves.
 - 6. Check valves.

1.02 RELATED REQUIREMENTS

- A. Section 23 05 16 - Expansion Fittings and Loops for HVAC Piping.
- B. Section 23 05 48 - Vibration and Seismic Controls for HVAC Piping and Equipment.
- C. Section 23 05 53 - Identification for HVAC Piping and Equipment.
- D. Section 23 07 19 - HVAC Piping Insulation.
- E. Section 23 21 14 - Hydronic Specialties.
- F. Section 23 25 00 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Welding, Brazing, and Fusing Qualifications; 2015.
- B. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300; 2011.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings; 2012.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings; 2013.
- E. ASME B31.9 - Building Services Piping; 2014.
- F. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings; The American Society of Mechanical Engineers; 2001 (R2005).
- G. ASME B31.9 - Building Services Piping; The American Society of Mechanical Engineers; 2008 (ANSI/ASME B31.9).
- H. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless; 2012.
- I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service; 2015.

- J. ASTM B32 - Standard Specification for Solder Metal; 2008 (Reapproved 2014).
- K. ASTM B88 - Standard Specification for Seamless Copper Water Tube; 2014.
- L. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric); 2013.
- M. ASTM F708 - Standard Practice for Design and Installation of Rigid Pipe Hangers; 1992 (Reapproved 2008).
- N. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications; 2007 (Reapproved 2013).
- O. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding; 2011-AMD 1.
- P. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2011 and errata.
- Q. AWS A5.8/A5.8M - Specification for Filler Metals for Brazing and Braze Welding; American Welding Society; 2004 and errata.
- R. AWS D1.1/D1.1M - Structural Welding Code - Steel; 2015.
- S. AWWA C606 - Grooved and Shouldered Joints; 2011.
- T. AWWA C606 - Standard Specification for Grooved and Shouldered Joints; American Water Works Association; 2006.
- U. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation; 2009.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalogue information. Indicate valve data and ratings.
- C. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- D. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
- E. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.05 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing products of the type specified in this section, with minimum three years of documented experience.
- B. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.
 - 2. Welder Certifications shall be submitted as part of the submittal data.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals. Provide shut off valve to allow for replacement of the fitting without draining the entire system. The shut off valve shall be constructed of the material matching the pipe it's on.
 - 3. Grooved mechanical joints are not permitted in any location.
 - 4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
 - 5. Provide pipe hangers and supports in accordance with ASME B31.9 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges or unions to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
 - 1. Provide drain valves where indicated, and if not indicated provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch gate valves with cap; pipe to nearest floor drain.
 - 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 - 3. For throttling, bypass, or manual flow control services, use globe valves.
 - 4. For throttling and isolation service in chilled and condenser water systems, use only butterfly valves.
 - 5. In heating water or chilled water systems, butterfly valves may be used interchangeably with gate and globe valves.
 - 6. For shut-off and to isolate parts of systems or vertical risers, use gate, ball, or butterfly valves.
- E. Welding Materials and Procedures: Conform to ASME BPVC-IX.

2.02 HEATING WATER PIPING, ABOVE GRADE

- A. The intent is to provide Copper Tube up to 2" and Steel piping for larger than 2". However we would like to minimize the change in materials therefore, should a condition be found that maintaining one piping material for a short length in a size not listed for that material would reduce the amount of dielectric fittings, this condition shall be presented to the engineer for review.
- B. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
- C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn, using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 - c. Braze: 1 BCuP copper/silver alloy.
 - 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.03 CHILLED WATER PIPING, BURIED

A. PIPE AND PIPING PRODUCTS

1. Pipe shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389 or CSA B137.11. The pipe shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All pipe shall be made in a three layer extrusion process. Hydronic hot water and heating piping shall contain a fiber layer (faser) to restrict thermal expansion. All pipe shall comply with the rated pressure requirements of ASTM F 2389 or CSA 8137.11. All pipe shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11
2. Pipe shall be Aquatherm® Climatherm® or Climatherm® Faser®, available from Aquatherm, Inc. or pre-approved equal.

B. FITTINGS

1. Fittings shall be manufactured from a PP-R resin meeting the short-term properties and long-term strength requirements of ASTM F 2389. The fittings shall contain no rework or recycled materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material. All fittings shall be certified by NSF International as complying with NSF 14, and ASTM F 2389 or CSA B137.11.
2. Underground chilled water piping shall be connected to above ground piping with a flanged connection. This connection shall occur at 12" to 18" above grade/floor unless otherwise noted.

C. WARRANTY

1. Manufacturer shall warrant pipe and fittings for 10 years to be free of defects in materials or workmanship.
2. Warranty shall cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or workmanship.

D. VALVES

1. Valves shall be manufactured in accordance with the manufacturer's specifications and shall comply with the performance requirements of ASTM F 2389 or CSA BI 37.11. The valves shall contain no rework or recycled thermoplastic materials except that generated in the manufacturer's own plant from resin of the same specification from the same raw material.

E. SMOKE AND FIRE RATINGS

1. Where indicated on the drawings that a Plenum-rated Piping System is needed, then the pipe shall be wrapped and/or insulated with standard pipe insulation, field installed. The pipe wrap or insulation shall meet the requirements of CAN/ULC-SI02.2-03 or ASTM E84. The system shall have a Flame Spread Classification of less than 25 and Smoke Development rating of less than 50.

F. UV PROTECTION

1. Where indicated on the drawings that the pipe will be exposed to direct UV light for more than 30 days, it shall be provided with a Factory applied, UV-resistant coating or alternative UV protection.

G. THERMAL AND VAPOR BARRIER

1. A. Where standard pipe insulation is indicated on the drawings or in these specifications, the contractor shall provide a thermal (radiant, conductive, and convective) and vapor barrier insulation. The insulation products shall be provided in 6R-value and 1.5" thickness or as indicated on the drawings or elsewhere in these specifications. The standard pipe insulation shall be UV resistant, CFC-free, non-porous, non-fibrous, and resist mold growth. The pipe with the insulation shall meet the ASTM E84 and the CAN/ULC SI02.2 requirements for a Flame Spread Rating of 25 and Smoke Development rating of 50.

2.04 CHILLED WATER PIPING, ABOVE GRADE

- A. The intent is to provide Copper Tube up to 2" and Steel piping for larger than 2". However we would like to minimize the change in materials therefore, should a condition be found that maintaining one piping material for a short length in a size not listed for that material would reduce the amount of dielectric fittings, this condition shall be presented to the engineer for review.
- B. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
 - 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 - 2. Threaded Joints: ASME B16.3, malleable iron fittings.
- C. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), hard drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: 1 BCuP copper/silver alloy.
 - 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.

2.05 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type K (A), drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.06 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
- B. Conform to ASME B31.9.
- C. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron, adjustable swivel, split ring.
- D. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
- E. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
- F. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
- G. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
- H. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
- I. Wall Support for Pipe Sizes 4 Inches and Greater: Welded steel bracket and wrought steel clamp.
- J. Vertical Support: Steel riser clamp.
- K. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.

2.07 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Less:
 - 1. Ferrous Piping: 150 psig malleable iron, threaded.
 - 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches and Greater:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Gaskets: 1/16 inch thick preformed neoprene.

2.08 GATE VALVES

- A. Manufacturers:
 - 1. Tyco Flow Control: www.tycoflowcontrol.com.
 - 2. Jomar Valve: www.jomarvalve.com
 - 3. Conbraco Industries: www.apollovalves.com.
 - 4. Nibco, Inc: www.nibco.com.
- B. Up To and Including 2 Inches:
 - 1. Bronze body, bronze trim, screwed bonnet, non-rising stem, lockshield stem, inside screw with backseating stem, solid wedge disc, alloy seat rings, solder ends.
- C. Over 2 Inches:
 - 1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, solid wedge disc with bronze seat rings, flanged ends.

2.09 GLOBE OR ANGLE VALVES

- A. Manufacturers:
 - 1. Tyco Flow Control: www.tycoflowcontrol.com.
 - 2. Jomar Valve: www.jomarvalve.com
 - 3. Conbraco Industries: www.apollovalves.com.
 - 4. Nibco, Inc: www.nibco.com.
 - 5. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Up To and Including 2 Inches:
 - 1. Bronze body, bronze trim, screwed bonnet, rising stem and handwheel, inside screw with backseating stem, renewable composition disc and bronze seat, solder ends.
 - 2. Balancing ports and caps must be provided with globe or angle valves used for balancing.
- C. Over 2 Inches:
 - 1. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.
 - 2. Balancing ports and caps must be provided with globe or angle valves used for balancing.

2.10 BALL VALVES

- A. Manufacturers:
 - 1. Tyco Flow Control: www.tycoflowcontrol.com.
 - 2. Jomar Valve: www.jomarvalve.com
 - 3. Conbraco Industries: www.apollovalves.com.
 - 4. Nibco, Inc: www.nibco.com.
 - 5. Milwaukee Valve Company: www.milwaukeevalve.com.
- B. Up To and Including 2 Inches:
 - 1. Bronze one piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.

2.11 MANUAL CALIBRATED BALANCING VALVES

- A. Valve Characteristics ½" to 2" "Y" Pattern Globe
 - 1. 300 psi/2065 kPa, y-pattern, globe type with soldered or threaded ends, non-ferrous Ametal® brass copper alloy body, EPDM o-ring seals. 4-turn digital readout handwheel for balancing, hidden memory feature with locking tamper-proof setting, and connections for portable differential meter. Tour and Andersson TA Series 786-STAS or 787-STAD or equal by Armstrong or Wheatley.
- B. Valve Characteristics 2 ½ to 16" "Y" Pattern Globe
 - 1. 300 psi/2065 kPa, y-pattern, globe type with flanged or grooved ends, ASTM A536 ductile iron body, all other metal parts of Ametal® brass copper alloy, EPDM O-ring seals. 8, 12, 16, 20 or 22 turn digital readout handwheel for balancing, hidden memory feature with

locking tamper-proof setting, and connections for portable differential meter. Tour and Andersson TA Series 788-STAF or 789-STAG or equal by Armstrong or Wheatley.

C. Balancing Meter

1. A balancing meter is required to be left with the owner after commissioning, the balancing meter shall be from the same provider as the balancing valves, Victaulic. The Series 734 TA-Scope, or TA Series 73M CMI Pressure Differential Meter are acceptable and are manufactured by Tour and Andersson and provided by Victaulic. Needle gauge type meters will not be allowed.

2.12 BUTTERFLY VALVES

A. Manufacturers:

1. Tyco Flow Control: www.tycoflowcontrol.com.
2. Hammond Valve: www.hammondvalve.com.
3. Crane Co.: www.craneco.com.
4. Milwaukee Valve Company: www.milwaukeevalve.com.

B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.

C. Disc: Construct of aluminum bronze, chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.

D. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.

E. Disc: Stainless steel.

F. Operator: Infinite position lever handle with memory stop.

2.13 SPRING LOADED CHECK VALVES

A. Manufacturers:

1. Tyco Flow Control: www.tycoflowcontrol.com.
2. Hammond Valve: www.hammondvalve.com.
3. Crane Co.: www.cranevalve.com.
4. Milwaukee Valve Company: www.milwaukeevalve.com.

B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- F. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for additional requirements.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and to avoid interfere with use of space.
- D. Group piping whenever practical at common elevations.

- E. Sleeve pipe passing through partitions, walls and floors.
- F. Slope piping and arrange to drain at low points.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 23 05 16.
 - 1. Flexible couplings may be used in header piping to accommodate thermal growth, thermal contraction in lieu of expansion loops.
- H. Inserts:
 - 1. Provide inserts for placement in concrete formwork.
 - 2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 - 3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches.
- I. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.9, ASTM F708, or MSS SP-58.
 - 2. Support horizontal piping as scheduled.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
 - 5. Use hangers with 1-1/2 inch minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 - 6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 - 7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 - 8. Prime coat exposed steel hangers and supports. Refer to Section 09 91 23. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- J. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 23 07 19.
- K. Use eccentric reducers to maintain top of pipe level.
- L. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- M. FUSION WELDING OF JOINTS
 - 1. Install fittings and joints using socket-fusion, electro-fusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
 - 2. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
 - 3. Prior to joining, the pipe and fittings shall be prepared in accordance with F 2389 and the manufacturer's specifications.
 - 4. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.
- N. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1 inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-1/2 inch and 2 inch: Maximum span, 8 feet; minimum rod size, 3/8 inch.

- B. Hanger Spacing for Steel Piping.
1. 2-1/2 inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 2. 3 inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 3. 4 inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 4. 6 inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 5. 8 inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
 6. 10 inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.
 7. 12 inches: Maximum span, 23 feet; minimum rod size, 7/8 inch.

END OF SECTION

HVAC UPGRADES & ROOF REPLACEMENT
OMB/DFM CONTRACT NUMBERS
MJ1002000012 & MJ1002000008

DELAWARE STATE POLICE FIRING RANGE
OCTOBER 2018

HYDRONIC PIPING
23 21 13-10

DEDC,LLC
16P008

SECTION 23 51 00
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Category IV appliance venting

1.02 RELATED REQUIREMENTS

- A. Section 23 52 23 - Gas Fired Hydronic Boilers

1.03 REFERENCE STANDARDS

- A. NFPA 54 - National Fuel Gas Code; 2015.
- B. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible; 2005.

1.04 DEFINITIONS

- A. Breeching: Vent Connector.
- B. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- C. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.05 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.
- D. Manufacturer's Instructions: Include installation instructions, and indicate assembly, support details, and connection requirements.

1.06 REGULATORY REQUIREMENTS

- A. Conform to NFPA 54 for installation of natural gas burning appliances and equipment.
- B. Conform to applicable code for installation of oil burning appliances and equipment.

PART 2 PRODUCTS

2.01 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS

- A. Regulatory Requirements:
 - 1. Conform to applicable code for installation of natural gas burning appliances and equipment.

2.02 FIELD FABRICATED BREECHINGS

- A. PVC for venting and make up air of category IV appliances shall be:
 - 1. PVC Schedule 40 pipe manufactured from a Type I, Grade I Polyvinyl Chloride (PVC) compound with a Cell Classification of 12454 per ASTM D1784. The pipe shall be manufactured in strict compliance to ASTM D1785 and D2665, consistently meeting and/or exceeding the Quality Assurance test requirements of these standards with regard to material, workmanship, burst pressure, flattening, and extrusion quality. The pipe shall be manufactured in the USA, using domestic materials, by an ISO 9001 certified manufacturer.
 - 2. Joined with PVC solvent - IPS Weld-On 724.

3. The plastic components, primers and glues of the vent system must be from a single system manufacturer and not inter-mixed with other manufacturers vent system parts.
 4. Painted with a water based paint to protect the piping exposed to UV rays (outside).
- B. Minimum Metal Thicknesses based on SMACNA (DCS):
 - C. Provide adjustable self-actuating barometric draft dampers, where indicated on drawings, full size of breeching.
 - D. Provide cleanout doors of same gage as breeching where indicated on drawings.
 - E. Reinforcing: Provide angle frames for rectangular breeching and flanged girth joints or angle frames for round breeching in accordance with SMACNA (DCS), at following intervals:

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54.
- C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA (DCS) for equivalent duct support configuration and size.
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- F. Level and plumb chimney and stacks.
- G. Clean breechings, chimneys, and stacks during installation, removing dust and debris.

3.02 SCHEDULES

- A. Breechings, Chimneys and Stacks.
 1. Boiler: PVC for venting of category IV appliances

END OF SECTION

SECTION 23 73 14
CUSTOM AIR HANDLING UNIT

PART 1 GENERAL

1.01 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Conduct a pre-installation meeting one week prior to the start of the work of this section; require attendance by all affected installers.
- B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.02 SUBMITTALS

- A. Electronic copies of this documentation shall be provided to engineer after bid is awarded. The electronic copy will be utilized for comments and final approvals.
- B. Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gages and finishes of materials, and electrical characteristics and connection requirements.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- C. Shop Drawings: Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, and electrical characteristics and connection requirements.
- D. Manufacturer's Instructions: Include installation instructions.
- E. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams. Instruction shall include schedule of all required unit maintenance for conformance with unit warranty and to maintain manufacturer's published performance.
- F. Maintenance Materials: Furnish the following for State of Delaware OMB - Division of Facilities Management's use in maintenance of project.
 - 1. See Section 01 60 00 - Product Requirements, for additional provisions.
- G. Submit schedule indicating all activities from receipt of approved submittals from the owner and engineer through unit shipment. Schedule shall include all major milestones associated with unit production including fabrication, assembly, testing and shipment. Provide weekly schedule updates to the owner and engineer.

1.03 QUALITY ASSURANCE

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

1.04 SCOPE OF WORK

- A. Custom built air handling units shall be supplied to meet the performance requirements shown on the equipment plans and specifications. To comply with job site constraints and/or freight restrictions, the units shall be shipped, Combination modular and partial knockdown construction (field assembled), ready for field installation. Shipping details shall be coordinated and included with submittal drawings.
- B. Prior to shipping the units from the factory, the units shall be inspected by the consulting engineer, owner or a representative assigned by the owner. Within 14 calendar days of receipt of approved submittals, manufacturer shall submit a detailed unit fabrication and testing schedule. Schedule shall clearly indicate dates and locations for all manufacturer's internal

quality assurance tests. Manufacturer shall confirm with owner testing date 4 weeks prior to each test.

- C. The contractor shall be responsible for inspecting the units upon arrival at the job-site or riggers yard. Any deficiencies and/or freight damage shall be documented to the factory within 24 hrs. Rigging, installation, sealing of modules and field start-up work shall be executed by the mechanical contractor as outlined in the project specifications.
- D. The Air Handling Unit Manufacturer shall warranty the equipment, parts only, for a period of two years commencing at the date of system commissioning including completion of the BAS system and associated ERU equipment and systems connected to the BAS, up to a maximum of thirty-six months from the date of shipment.
- E. The unit shall consist of the following primary components:
 - 1. OA intake Plenum
 - 2. OA Filter (High Capacity Bag Type)
 - 3. Supply Air Fan Array
 - 4. Energy Recovery Run-Around Coil (see Specification 23 82 16 Air Coils)
 - 5. 30% Propylene Glycol Chilled Water Coil
 - 6. Supply Air Discharge Plenum
 - 7. Exhaust Intake Plenum
 - 8. Exhaust Air Filters (Pre-Filter and HEPA Both Bag In Bag Out Type)
 - 9. Exhaust Air Fan Array
 - 10. Exhaust Air Discharge Plenum
 - 11. Mechanical Space (heated and ventilated).

1.05 REFERENCES

- A. The design and fabrication of the units shall be in accordance with the latest standards listed herewith:
 - 1. AFBMA 9 Load ratings and fatigue life for ball bearings
 - 2. AMCA 203 Field performance measurements
 - 3. AMCA 210 Laboratory methods of testing fans for rating purposes
 - 4. AMCA 300 Test code for sound rating air moving devices
 - 5. AMCA 500 Test methods for louvers, dampers and shutters
 - 6. ARI 410 Forced-circulation air cooling and air heating coils
 - 7. ASHRAE 62-89 ventilation for acceptable indoor air quality
 - 8. ASTM A525 Steel sheet, zinc coated by hot-dip process
 - 9. ASTM E90-09 Standard for Measurement of Airborne Sound Transmission Loss.
 - 10. NEMA MG1 National electrical manufacturers association (Motors and generators)
 - 11. NFPA 70 National fire protection code
 - 12. NFPA 90A Installation of Air Conditioning and Ventilation Systems
 - 13. OSHA Occupational safety and health administration
 - 14. SMACNA HVAC metal duct association
 - 15. UL 900 Underwriters laboratory, (test performance of air filters quality)
- B. Drawings shown on project plans and specifications.
- C. Equipment schedules shown on project plans and specifications.

1.06 QUALITY ASSURANCE

- A. The following parameters define the selection criteria and are to be specified: Airflow rates, external static pressures, water flow rates, electrical power supply. The following parameters are to be as specified or improved upon: Coil face velocity, filter velocities, internal static pressure losses, cabinet air leakage, electrical power consumption, discharge/inlet and radiated sound power levels.

- B. The quality control program shall ensure the consistency of the product and the effectiveness of the production processes.
- C. All components and equipment shall be sourced from established HVAC manufacturers whose products comply with their product-specific industry standards.
- D. Water and Glycol Coils shall be ARI Certified / ARI Rated
- E. ERU and associated components shall be factory tested according to ARI 430: Central-Station Air Handling Units and shall be listed and labeled by ARI.
- F. Filter media shall be UL listed.

1.07 SUBMITTAL DRAWINGS

- A. Unit Manufacturer shall provide submittal drawings showing the arrangement of each unit, nominal dimensions, weight of each shipping module and complete technical data for all mechanical and electrical accessories provided with the HVAC units.
- B. The drawings shall detail the cross-section of the floor, perimeter structure, panel assembly, sealing between panels and detailing of all components including the material and thickness of all cabinetry components including R value of the unit casing. Unit casing details verifying complete thermal break and no through metal fabrication for unit floor, walls and roof to be provided.
- C. If the unit is shipped in a full or partial knock down configuration, all AHU components shall be coordinated with the contractor for fields fit. All cabinet parts and OEM equipment shall be clearly listed with sizes and weights.
- D. Fan performance ratings shall have been based on tests and procedures performed in accordance with AMCA publication 211 and publication 311 and comply with the requirements of the AMCA Certified Ratings Program. The fan operation shall be clearly indicated including the impact of any system effect factors. For reference purposes, a family of performance curves shall be included for each fan. Sound power levels shall be provided for the fan inlet and discharge at each octave band. Construction drawings for each fan shall be included with the submittal drawing file.
- E. Heat transfer coils' selection data for each coil shall be included with submittal drawing file. The selection must indicate all input & output values as well as the characteristics of the fluids. Construction drawings for each coil bank shall be included with the submittal drawing file.
- F. A detailed description of the filters including their "dust spot" efficiency evaluated under ASHRAE standard 52.1-1992, UL class, initial and final pressure losses for each filter bank shall be provided with the submittal drawings.
- G. Unit assembly view shall be provided indicating each individual section to be shipped with required location and orientation for complete field assembly.

1.08 DELIVERY, STORAGE AND HANDLING

- A. The units shall be thoroughly cleaned and inspected before applying a shrink wrapping protective cover. The plastic cover shall completely enclose shipping units individually.
- B. The units shall be shipped Combination of modules and knockdown, as documented in the specifications or instructed by contractor. The units and/or modules shall be equipped with adequately sized and removable lifting lugs for field rigging and handling.
- C. The units must be handled carefully in the field to avoid damaging internal components, cabinet walls and exterior finish.
- D. Factory applied shrink wrap is intended to protect the units while in transit to the job site. The units must be stored in a dry, clean environment protected from the outdoor weather. The units must not be stored with the factory applied shrink wrap. The intention of the shrink wrap is to protect the units during transit.

- E. The units must not be operated, for temporary or permanent purposes, until the official start-up is completed by the mechanical contractor and witnessed by a manufacturer's representative.

PRODUCTS

2.01 MANUFACTURERS

- A. Ingenia (Basis of Design)
- B. Substitutions: A date for requests and substitutions shall be set at the pre-bid meeting. Prior to this date a full submittal of any substituted manufacturer shall be provided to the engineer for review.
 - 1. The substitution submittal shall include the following as a minimum:
 - a. Physical Dimensions of unit in plan and elevation. All access locations to be shown on these documents
 - b. Capacity information for coils, fans, filters, etc.
 - 1) Performance run for chilled water coil at 50% OA and 100% OA
 - 2) Energy Recovery System performance at 50% OA and 100% OA (coils, HX, etc.)
 - c. Unit construction specifications identifying wall thickness, insulation, painting, materials, and expected deflection and leakage.
 - d. Line by line specification comparison indicating deviations.
- C. See Section 01 60 00 - Product Requirements for additional information.

2.02 UNIT PERFORMANCE

- A. Provide factory fabricated custom air handlers units having overall dimensions as shown on the construction plans. Physical dimensions and unit arrangement are critical for equipment layout and must be as shown on the plans.
- B. Refer to the custom air handler schedules to determine the performance of all internal components: Fans, coils, filters, humidifiers, acoustical performance, etc.
- C. The indicated total static pressure for each fan must be equal to the sum of the external static and the internal static, including all internal system effects.
- D. The fan performance characteristics must be based on the actual elevation and operating temperature. Supply fan performance must be identified in ACFM at the following ambient temperatures:
 - 1. 0 degrees F
 - 2. 30 degrees F
 - 3. 60 degrees F
 - 4. 95 degrees F
- E. All deviations from the specified must be clearly indicated on the submittal drawings. The contractor shall be held responsible for all additional expenses associated with the substitution of the specified product.

2.03 CABINET DESIGN PRESSURE (3" CABINET WALL MINIMUM)

- A. The cabinet shall be designed to resist either the fan shut-off pressure or a maximum static of 12" w.g., the highest value shall be considered the maximum design static. The maximum panel deflection shall be 1/240 along the panel's length center-line. Air leakage shall not exceed ½ % of the total design air flow at the maximum design static pressure or the cfm allowed for by SMACNA leakage class 3. The greater leakage rate is the acceptable maximum leakage.

2.04 CABINET CONSTRUCTION

- A. UNIT BASE

1. The unit shall be constructed on a Galvanized Steel base. The base shall be designed to distribute loads properly to a suitable mounting surface and be braced to support internal components without sagging, pulsating or oil canning.
 2. The floor perimeter support structure of each air handling unit shall be built with Galvanized Steel HSS members. Framing members shall be joined with 3/8" tapered head machine bolts. Perimeter corner segments shall be joined with galvanized steel precision machined adjoining corners. All assembly hardware shall be consistent with the basic construction material type: Galvanized Steel.
 3. The base frame height shall be selected to meet the structural design load. The maximum base deflection shall not exceed 1/300, given a maximum unsupported span of 8 feet [96"].
 4. To minimize thermal gain/losses through the perimeter channel supports, the perimeter frame shall be thermally isolated from the casing. The thermal barrier shall have an R value equal or better than 0.4 per inch.
 5. To ensure sufficient height for field installed condensate P-traps, the minimum height of the perimeter channels shall be 6 inches.
 6. Each shipping module shall be equipped with a minimum of four (4) removable lifting lugs. Intermediate lifting lugs shall be provided if length and/or width of unit requires it.
 7. To ensure sustained product life, all structural base components shall be made of galvanized steel material. Painted carbon steel components shall not be utilized unless they are baked powder coated or sand blasted and finished with a baked enamel coating. If the base components are powder coated, then the process shall be the following:
 - a. Paint shall be applied in an electrostatic powder coating system. The electrostatic spraying shall be accomplished by applying an electrical charge to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded workpiece create an electrostatic field that pulls the paint particles to the workpiece. The coating deposited on the workpiece retains its charge, which holds the powder to the workpiece. The coated workpiece is placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated. The paint system shall be environmentally friendly, therefore eliminating the use of volatile organic compounds (VOC's), hazardous air pollutants (HAP's) and solvents. Individual panels must be painted prior to final assembly to ensure painting of all sheared metal edges and concealed surfaces. The paint coating shall resist 5000 hours to the standard ASTM-B117 salt spray test.
 - b. The powder coating process shall include: Pre-washing; Rinsing; Re-washing; Rinsing cycle I; Rinsing cycle II; Oven dry @ 400 deg F; Electrostatic paint application (powder format); Baked finish @ 400 deg F
- B. FLOOR SURFACE - INSULATION - UNDERLINER**
1. The internal, visible floor surfaces shall be Diamond plate 12 GA. thick G90 Galvanized Steel.
 2. Floors shall be 2" recessed/drainable. All recessed drainable floors shall have machined aluminum single piece catch basins with removable 304 stainless steel grates. Drain connections shall be 1-1/4" MPT Aluminum.
 3. The underside floor space shall be sprayed with a minimum 3" inch layer of polyurethane foam. The thermal resistance shall be R-19.5.
 4. The underside liners shall be G-90 Galvanized Steel.
 5. To minimize thermal gains/losses through the floor system, the perimeter frame and all internal cross members shall be totally thermally isolated from the floor and cabinet. The NO-THROUGH-METAL barrier shall have an R value equal or better than 0.4 per inch.
- C. INSULATED UNIT CASING (R19.5 MINIMUM)**
1. All panels shall be double wall construction, load-bearing and capable of forming the enclosure without additional structural members. All panel joints shall be sealed to provide

a permanent air-tight seal. The panels shall have a maximum deflection of 1/240 at the specified conditions.

2. Individual panels shall be made with two shells inter-connected to each other with metal fasteners every 12" In order to achieve a high performance thermal break characteristic, the interconnecting metal-to-metal contact shall not exceed 12 % of any given panel perimeter.
3. All inner and outer panels shall be G-90 Galvanized Steel.
4. All panels shall be a minimum 3" thick and be insulated to have an R-value equal to 19.5, as tested by an independent lab using the following procedure: ASTM C1363-05 Standard Test Method for Thermal Performance of Building Materials and Envelop Assemblies by means of a hot box apparatus.
5. Adjacent panels shall be assembled to each other with bolted G-90 Galvanized Steel compression plates. The cabinet shall be air and water tight by individually sealing each panel joint with compressed rubber butyl membranes. The compression plates shall be mounted on the exterior of the units, the assembly bolts shall be exposed to the exterior of the unit. Self-tapping screws are not acceptable due to their inherent inability to maintain torque over the life of the product.
6. To prevent internal cabinet corrosion, all air-side panel joints shall include a SOLID VAPOR BARRIER thereby preventing moisture migration into the wall space. The internal seal shall be resistant to pressure wash down cycles

D. ACCESS DOOR

1. All access doors shall be provided as shown on plans. Generally on the side with access to the mechanical drive and piping side of the air handling unit. All access doors exposed to the weather shall have rain gutters to prevent water from running down on the door framing system.
2. Door panels shall be made with two shells inter-connected to each other with metal fasteners. In order to achieve a high performance thermal break characteristic, the interconnecting metal-to-metal contact shall not exceed 12 % of any given panel perimeter.
3. The door panels shall be double wall. To prevent air leakage and provide a rigid design, the external skin shall include all the forming segments of the double gasket base support. The door frame shall be made of a dual heavy gauge G-90 Galvanized Steel and shall be bolted to the cabinet wall panels.
4. Each access door shall be equipped with two stainless steel hinges and two latches which shall be operable from the inside and outside of the unit. The handles shall be easy to operate and be made of Aluminium Alloy.
5. The air seal between the door and its frame shall be accomplished with a dual formed in place foam gasket extruded EPDM (PIPGF). The dual gasket system is designed to provide two points of a contact providing a high level of thermal resistance. The gaskets shall be continuous with single bonded joints.
6. Doors shall open out/in against unit pressure. Doors opening with the pressure shall be installed with interlock switches and/or safety latches to prevent full open position of the door.
7. All access doors shall have a built-in static pressure port for ease of reading static pressure across internal components and limit unnecessary or unauthorized access inside the unit.
8. All access doors shall be lockable. Contractor to coordinate coring with DFM.

E. ACCESS PANELS

1. Each unit shall have easy access for maintenance and service through side access doors or removable access panels.
2. Access panels shall be provided on the connection side of the heat transfer coil sections to extract the coils for replacement purposes. The access panels shall have the same

thickness as the nominal cabinet wall thickness. The access panels shall be sealed to the cabinet with butyl polymer membranes and bolted to high strength compression fittings for the ease of removal. Grommets are used to make a seal between the pipe connections and the panel openings.

3. Access panels shall be made with two shells inter-connected to each other with metal fasteners at 12" intervals.
4. Access panels shall be bolted to inserts located within the periphery of the wall opening. The air seal shall be accomplished with rubber butyl membranes and compression plates. Access panels secured to the wall cabinet by means of self-tapping screws shall not be acceptable

F. COOLING COIL SECTION

1. Drain pans shall be made of 16 GA. 304 stainless steel, to ensure positive water flow their surfaces shall be multi-sloped and have a depth of 3". Floor drain diameters shall be 1-½". The material shall be schedule 40-pipe 304 stainless steel, MPT both ends. The drain extensions shall be securely fastened to a female adaptor welded to the catch basin underneath the drain hub. The drain connection shall be accessible from the exterior of the unit casing.
2. Stacked cooling coils shall have independent multi-sloped drain pans. Secondary "gutter" drain pans shall not be acceptable. The secondary drain pan racking system shall be made entirely of 304-stainless steel.
3. Unit shall have independent drain connections extended outside the cabinet. Drain material shall be as indicated under paragraph # 1. Each external drain connection requires an independent external P-trap, provided and installed by others
4. The cooling coil racking system must be designed to allow for the individual removal of multi-stacked or side-by-side coils. Stacked cooling coils shall have independent accessible panels. Therefore, providing the ability to remove individual stacked coils
5. The interior panels of the cooling coil sections shall be solid Galvanized Steel, its thickness and finish shall be consistent with the air handler cabinet

G. PIPING CONNECTIONS

1. All piping connections that extend to the exterior to the casing shall do so through neoprene rubber seals. Cooling coil connections shall have double seals and heating coils shall have single exterior seals.
2. Single horizontal coil units must have all coil connections on the access door side, unless otherwise specified.
3. The air handling unit manufacturer shall provide piping supports required to pipe the energy recovery coils and chilled water coils.

H. FAN SECTION (FLOOR MOUNTED)

1. Fan and motor assemblies shall be mounted on welded and powder coated integral bases. The entire assembly shall be supported by 2" deflection seismic isolators. The isolators shall be selected to provide isolation efficiency equal to 95% or better.
2. To obtain optimum aerodynamic performance, plenum fans shall be centered in the cabinet. To minimize pressure losses due to internal system effects, the minimum distance from the tip of the wheel to the inside surface of the cabinet shall be at least ½ of the wheel diameter.
3. To prevent injuries, access doors shall open against the positive pressure, therefore towards the inside of the fan section. Motor position relative to the fan shaft shall be X-Y and opposite the access door.
4. Fans shall be equipped with horizontal thrust limiting restraints to ensure stable operation and also prevent the flexible connecting canvas from tearing.

I. EQUIPMENT BLANK-OFFS

1. Forced convergence of air streams towards the core area of internal equipment shall be accomplished with blank-off plates. The blank off material shall be 16GA. G-90

Galvanized Steel. Typical equipment requiring blank-offs are: Coil banks, filters, dampers, etc. The blank-offs must be securely fastened to the internal side walls and adjacent internal equipment. The blank material shall be as specified under the specific modular segment.

2. A 16" blank panel shall be provided at each coil section to allow for piping to be routed thru the unit. Piping to be routed in field with sleeves. Sleeves to be sized to accommodate pipe and insulation and shall be sealed to the blank off panel with gaskets. Annular space between pipe and sleeve to be filled with insulation to minimize air flow.

J. AUXILIARY FLOOR DRAIN PANS

1. Provide Multi-sloped recessed floors with auxiliary threaded pipe drain connections in the air handler floor sections as indicated on the plans. The connection material shall be the same as the internal section floor surface. The drain pipes shall be connected to catch basins equipped with removable gratings.

K. MODULAR ASSEMBLY

1. Modular connections shall be the same as panel connections. To minimize field labor, rivet-nut inserts shall be installed at the factory for easy field bolting. Butyl gasket/membrane shall be provided for field installation on the exterior adjoining modules. Stainless Steel bolts shall be provided for field installation around the full perimeter of the connection joint. All modular connections shall be joined at the factory to verify alignment before shipping.

L. EXTERIOR FINISH

1. The Exterior surfaces of the air handler shall be powder coated.
2. The Exterior finish shall be TEXTURED BONE WHITE (final color selection by owner during submittal process)
3. The powder coating process shall include: Pre-washing; Rinsing; Re-washing; Rinsing cycle I; Rinsing cycle II; Oven dry @ 400 deg F; Electrostatic paint application (powder format); Baked finish @ 400 deg F.
4. Paint shall be applied in an electrostatic powder coating system. The electrostatic spraying shall be accomplished by applying an electrical charge to the dry powder particles while the component to be painted is electrically grounded. The charged powder and grounded work piece create an electrostatic field that pulls the paint particles to the work piece. The coating deposited on the work piece retains its charge, which holds the powder to the work piece. The coated work piece is placed in a curing oven, where the paint particles are melted onto the surface and the charge is dissipated. The paint system shall be environmentally friendly, therefore eliminating the use of volatile organic compounds (VOC's), hazardous air pollutants (HAP's) and solvents. Individual panels must be painted prior to final assembly to ensure painting of all sheared metal edges and concealed surfaces. The paint coating shall resist 1000 hours to the standard ASTM-B117 scratch salt spray test and resist 5000 hours to the standard ASTM-B117 exposure salt spray test.

2.05 SUPPLY AND EXHAUST FANS

A. FAN ARRAY SYSTEM

1. The Fan Array system shall consist of multiple, direct driven, arrangement N plenum fans constructed per AMCA requirements, class as specified on the schedule.
2. The Fan Array system shall be selected in an N+1 arrangement. Meaning that N fans shall be capable of scheduled CFM and scheduled External Static Pressure @ 60 Hz (max).
3. Each fan within the Fan Array shall be connected to an individual VFD. VFD to be provided by BAS contractor and wired by Electrical Contractor in the field.
4. Basis of design unit has 8 fans in each array, therefore 7 fans shall be capable of scheduled CFM and scheduled External Static Pressure @ 60 Hz (max).

- B. Fans shall have a sharply rising pressure characteristic extending through the operating range and continuing to rise beyond the peak efficiency to ensure quiet and stable operation. Fans shall have a non-overloading design with self-limiting horsepower characteristics and shall reach a peak in the normal selection area. All fans shall be capable of operating over the minimum pressure class limits as specified in AMCA's Standard 2408-69.
- C. PERFORMANCE - Fans shall be tested in accordance with AMCA 211 and AMCA 311 test codes for air moving devices and shall be guaranteed by the manufacturer to deliver rated published performance levels. Fans shall be licensed to bear the AMCA certified ratings seal for both sound and air.
 - 1. Performance data on fans with shaft, bearings, and bearings bar in the inlet shall be de-rated to account for inlet restrictions and shall be licensed to bear the AMCA certified ratings seal for both sound and air.
- D. CONSTRUCTION - Fans shall be designed without a scroll type housing and shall incorporate a non-overloading type backward inclined airfoil blade wheel, heavy-gauge reinforced steel inlet plate, structural steel frame, and shaft and bearings.
- E. FRAME AND INLET PLATE - Inlet plates shall be of heavy-gauge reinforced steel construction. The inlet plate incorporates a removable spun inlet cone designed for smooth airflow into the accompanying inlet retaining ring of the fan wheel. A square, formed lip suitable for attachment of a boot connector shall surround the unit, or an optional round inlet collar can be provided
- F. WHEEL - Wheels shall have a spun non-tapered style blade, retaining ring on the inlet side to allow higher efficiencies over the performance range of the fan. Sizes 245 and smaller shall have airfoil-shaped extruded aluminum blades. Sizes 270 and larger shall have die-formed airfoil steel blades with the option of extruded aluminum blades. All wheels on direct drive arrangement 4 fans shall have airfoil-shaped extruded aluminum blades. All hollow blade wheels shall be continuously welded around all edges. Wheels shall have nine blades for high efficiencies. All wheels shall be statically and dynamically balanced on precision electronic balancers to a level of G6.3 (per ANSI 2019) or better.
- G. FINISH AND COATING - The entire fan assembly, excluding the shaft, shall be thoroughly degreased and deburred before application of a rust-preventive primer. After the fan is completely assembled, a finish coat of paint shall be applied to the entire assembly. The fan shaft shall be coated with a petroleum-based rust protectant. Aluminum components shall be unpainted.
- H. MANUFACTURER FIELD RUN TEST - All fans shall be completely assembled and test run with VFDs as a unit at the specified operating range and maximum RPM allowed for the particular construction type. Each wheel shall be statically and dynamically balanced in accordance with ANSI/AMCA 204-96 "Balance Quality and Vibration Levels for Fans" to Fan Application Category BV-3, Balance Quality Grade G6.3. Balance readings shall be taken by electronic type equipment in the axial, vertical, and horizontal directions on each of the bearings. Records shall be maintained and a written copy shall be available upon request.
 - 1. All motors shall be standard pedestal mounted type, (TEFC), T-frame motors selected at the specified operating voltage, RPM, and efficiency as specified or as scheduled elsewhere. All motors shall include isolated bearings or shaft grounding. Each fan/motor cartridge shall be rigidly mounted on 2 inch deflection vibration isolators and balanced as an assembly to 0.12 inches / second filter in. For efficient operation in a direct drive application, motors shall be capable of running continuously from 0 to 120Hz and deliver full rated horsepower at 60 to 120Hz operating frequencies. All motors shall maintain a minimum service factor of 1.15 throughout a 60 to 120Hz operating range.
 - a. For all fan arrays, maximum individual motor size is 50 HP.
 - 1) Fan wheels shall be aluminum airfoil type with minimum 9 blades, and fully welded.

- 2) The fan array shall be provided with acoustical liners that reduce the bare fan discharge sound power levels as scheduled. The silencers shall not increase the fan total static pressure, nor shall they increase the airway tunnel length of the Air Handling Unit when compared to the same fan array unit without the silencer array.
 - 3) The fan array shall consist of multiple fan and motor "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein.
 - 4) The Fan array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit not to exceed the specified cooling coil and/or filter bank face velocity when measured at a point 12" from the intake side of the Fan array intake plenum wall, and at a distance of 48" from the discharge side of the Fan plenum wall.
 - (a) Each fan/motor "cell" will be provided with an individual back-draft damper. Backdraft dampers shall be extruded aluminum on frames and blades and engineered to produce minimum static pressure loss at the designed operating conditions. Seals shall be solid rubber. Bearings shall be rubber shielded radial ball bearings, permanently lubricated.
 - 5) Provide a sliding motor removal rail in all fan sections.
- I. FAN ARRAY ELECTRICAL SYSTEM EQUIPPED WITH AC MOTORS:
1. Fan Array with Variable Frequency Drive Control:
 - a. Provide dedicated Variable Frequency Drives to start and run all motors in each Fan Array System. Variable Frequency Drives shall be supplied by the BAS contractor and field installed within the unit by the electrical contractor. The Variable Frequency Drives shall meet specifications section 23 09 69.
 - b. Each motor shall have a dedicated VFD provided by BAS/Mechanical Contractor and installed in field by the electrical contractor.
- J. FAN MOTOR, COIL, AND PIPE LIFTING AND HANDLING RAILS
1. Fan/motor and coil sections shall include lifting rails to facilitate the lifting and handling of the fan motor, coils, and piping to the exterior of the AHU cabinet.
 2. The rails shall include an extendible mechanism to ensure that the motors can be handled to the exterior of the AHU cabinet.
 3. Rails shall be structural high grade carbon steel and shall be finished with a powder coated safety yellow.
 4. By means of columns and beams, the system load must be transfer to the AHU floor framing system.
 5. Lift trolley shall be included with the unit.
 6. A lift trolley and rail shall be provided in the first floor service corridor (as shown on drawings) to trolley motors out of the unit.
 7. An access door shall be provided in 2nd floor service corridor to drop motors from 2nd floor level to 1st floor level.

2.06 CHILLED WATER COOLING COIL

- A. Glycol coils shall have cooper headers and red brass threaded connections. Drain and vent connections shall be incorporated into the header and extended to the exterior of the casing.
- B. The coil frame material shall be galvanized steel.
- C. The tubes shall be copper with a nominal diameter of 5/8" and 0.025" thick rifled wall.
- D. Heat transfer fins shall be aluminum and shall have a nominal thickness of 0.008".
- E. The coils shall be coated with No corrosion protection.
- F. Water control flow shall be done by TWO Way valve. The valve shall be FIELD installed and provided by BAS/Mechanical contractor.

2.07 AIR FILTERS

A. RETURN / EXHAUST PRE-FILTER

1. The return / exhaust air stream shall be filtered with a high capacity bag filter equal to Camfil Hi-Flo ES which will act as a pre-filter to the HEPA filters. The filter tracks shall be 304 stainless and shall be "Bag In Bag Out" type.
2. Pre-filters shall have a minimum efficiency rating of MERV 15. Pre-filters shall be 22" deep and not exceed 0.62" wg at rated capacity for the for the return / exhaust air stream.
3. Three (3) sets of spare pre-filters shall be provided.

B. EXHUAST HEPA FILTERS

1. The exhaust air stream shall have HEPA filters. The HEPA filter shall be IEST Type C equal to Camfil Absolute VG-SR high efficiency high capacity V-bank filter with CamContain GB housing for both HEPA and Pre-Filters.
2. The filter shall have a tested efficiency of 99.97% @ 0.3 Micron when evaluated under the guidance of IEST TEST A Recommended Practice RP-CC001. The Initial resistance to airflow shall not exceed 1.0" w.g. at rated capacity. Filter shall be rated by Underwriters Laboratories as UL Class 900. The filter shall be capable of withstanding 10" w.g. without failure of the media pack. The filter shall be labeled as to tested efficiency, rated/tested airflow, pressure drop and shall be serialized for identification.
3. Three (3) sets of spare HEPA filters shall be provided.

C. OA INTAKE FILTERS

1. The outside air stream shall be filtered with a high capacity bag filter equal to CamFil Hi-Flo ES.
2. This filter shall be front loading with Camfil FastFrame filter holding frames. Frames to be galvanized steel with compression tabs and replaceable gaskets.
3. This filter shall be rated at MERV 13, shall be 22" deep and shall not exceed 0.38" w.g. at rated capacity.
4. Three (3) sets of spare outside air filters shall be provided.

D. Filter Static Pressure Measurement

1. Filter static pressure shall be measured at each bank of filters by Pressure differential Magnehelic guages with unit mounted dials.

2.08 ENERGY RECOVERY - RUN AROUND COIL

- A. See Specification 23 82 16 Air Coils for Run Around Coil Specifications

2.09 FABRA HOOD INTAKE GRAVITY VENTILATOR

A. General Description:

1. Ventilator is low silhouette for intake applications with natural gravity or negative pressure system
2. Selection based on non-ducted applications
3. Intake units with throat widths through 42 inches are ship assembled when throat lengths do not exceed 84 inches
4. Each fan shall bear a permanently affixed manufacture's nameplate containing the model number and individual serial number

B. Hood and Base:

1. Material Type: Galvanized
2. Hood Constructed of precision formed, arched panels with interlocking seams
3. Vertical end panels are fully locked into hood end panels
4. Base height is standard of 5 inches
5. Curb cap is six inches larger then throat size
6. Curb cap has pre-punched mounting holes for installation

C. Birdscreen:

1. Constructed of ½ inch Galvanized mesh.
 2. Mounted horizontally across the intake area of the hood
- D. Hood Support:
1. Constructed of galvanized steel and fastened so the hood can either be removed completely from the base or hinged open
- E. Options/Accessories:
1. Dampers:
 - a. Type: Motorized
 - b. Prevents outside air from entering back into the building when fan is off
 - c. Balanced for minimal resistance to flow
 - d. Galvanized frames with prepunched mounting holes
 - e. Type: To match Custom air handling unit.
 2. Insect Screen:
 - a. Constructed of fine mesh aluminum
 - b. Fitted to the top of the throat and prevents entry of insects
 - c. Coating Type: Baked Enamel
 3. Tie-Down Points:
 - a. Four aluminum brackets located on hood supports, secures fan in heavy wind applications

2.10 ELECTRICAL

- A. Light Fixtures: To be furnished and installed by the contractor in accordance with the electrical drawings.
- B. Switches: To be furnished and installed by the contractor in accordance with the electrical drawings.
- C. GFCI Receptacles: To be furnished and installed by the contractor in accordance with the electrical drawings.
- D. Factory scope of work: The unit manufacturer shall furnish and wire a complete electrical system within the unit for the 120 volt load components. All 120 volt components shall be wired to terminate at a switch/junction box located within the service corridor for field connection to breaker panel / load center by electrical contractor. Each circuit shall not exceed 20 amps.
- E. Supply and Exhaust Fans: The unit manufacturer shall furnish conduit and pull strings (in accordance with the NEC) to allow the electrical contractor to pull wire from the service corridor to the electric fan motors within the air stream. Unit manufacturer shall seal conduit penetrations between air stream and service corridor. The electrical contractor will extend conduit from service corridor penetration to the VFD and power source.
- F. Wiring and Conduit: The unit wiring shall be stranded copper wire sheathed in a THHN covering, which will be distributed through the unit in EMT conduit; the use of aluminum wire or BX cable is prohibited. To allow for adjustment of fan motors, a 3'-0" section of weatherproof flex connect shall be provided at each motor. A separate ground wire for each motor shall be connected to a terminal in the disconnect switch. In addition to the requirements herein, wiring shall comply with NEC requirements. Inter-modular wiring shall terminate in a coiled configuration at the end of each module. The contractor shall pull the cables through the modules to complete the system wiring.

2.11 MICROPROCESSOR CONTROLS

- A. Microprocessor controls shall be field installed by BAS contractor in accordance with section 23 09 50.

2.12 MECHANICAL EQUIPMENT SPACE

- A. Unit to be provided with an integral mechanical space. Space width and height shall be as indicated on drawings. Mechanical space to be of the same construction as the unit previously

described with the same thermal resistance and structural performance. Mechanical space floor shall be level without obstructions such as at joining selections that might act as trip points.

- B. Provide a 3KW 3/60/460V electric unit heater with wall mounted thermostat for maintaining a minimum of 50°F temperature during winter operation. Provide factory mounted and wired heater, disconnect switch and thermostat. Provide conditioned ventilation for removing heat of variable speed drives and other devices within the vestibule. Conditioned ventilation may be taken from the unit supply and relieved via a louver in the service corridor. The louver shall have a weighted backdraft damper. Unit Manufacturer shall identify air volume being supplied to the service corridor in submittal.
- C. The mechanical space shall provide for floor and wall supporting of field piping installations. The support structure shall include a means for pipe hangers to be attached to supporting members. The support members shall be three feet on center and sized to support a uniform piping load of 250 lbs./ft.
- D. The mechanical space shall be equipped with a 2" floor drain for service.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Bolt sections together with gaskets.
- C. Isolate fan section with flexible duct connections.
- D. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- E. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as indicated. Refer to Section 23 05 48. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- F. Arrange installation of unit to provide access for space around ERU for servicing and maintenance
- G. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.
- H. Make connections to coils with unions or flanges.
- I. Hydronic Coils:
 - 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 - 2. Connections:
 - a. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line. Shut off and balancing valves shall be provided to isolate each individual coil within the air stream.
 - b. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - c. Install piping within service corridor to allow service and maintenance.
 - d. Connect condensate drain pans using NPS 2, ASTM B 88, Type M (ASTM B 88M, Type C) copper tubing or 304 SS tubing. Extend to grade at owner approved location
 - 3. Locate water supply at bottom of supply header and return water connection at top.
 - 4. Provide manual air vents at high points complete with stop valve.
 - 5. Ensure water coils are drainable and provide drain connection at low points.

3.02 FIELD QUALITY CONTROL

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

- B. Assembly:
 - 1. Provide a factory-trained and factory-employed technician to assist with planning and coordination of unit assembly. Technician shall be available on site during unit assembly and installation.
- C. Vibration Analysis:
 - 1. Measure vibration levels with an FFT (Fast Fourier Transformation) analyzer.
 - 2. Characteristics:
 - a. Frequency Response Range: 5 Hz thru 10 KHz (300 thru 600,000 cpm).
 - b. Capability to use a Hanning window.
 - c. Capacity to perform ensemble averaging.
 - d. Auto-ranging frequency amplitude.
 - e. Minimum amplitude accuracy over the selected frequency range of plus/minus 20 percent or plus/minus 1.5 dB.
 - 3. Use accelerometer, stud-mounted to collect data.
 - 4. Ensure the mass of the accelerometer and its mounting have minimal influence on the frequency response of the system over the selected measurement range.

3.03 AHU FIELD PRESSURE TEST AND INSPECTION

- A. Manufacturer's factory-trained and factory-employed service technician shall perform a field pressure test and inspection of unit and installation prior to startup. Technician shall field pressure test and inspect and verify the following as a minimum:
- B. Field Inspection
 - 1. Damage of any kind
 - 2. Level installation of unit
 - 3. Proper reassembly and sealing of unit segments at shipping splits.
 - 4. Tight seal around perimeter of unit at the roof curb or duct connections
 - 5. Installation of shipped-loose parts, including filters, backdraft dampers, air hoods, bird screens
 - 6. Completion and tightness of electrical, ductwork and piping connection
 - 7. Tight seals around wiring, conduit and piping penetrations through AHU casing.
 - 8. Supply of electricity from the building's permanent source
 - 9. Integrity of condensate trap for positive or negative pressure operation
 - 10. Condensate traps charged with water
 - 11. Removal of shipping bolts and shipping restraints
 - 12. Sealing of pipe chase floor(s) at penetration locations
 - 13. Tightness and full motion range of damper linkages (operate manually)
 - 14. Cleanliness of AHU interior and connecting ductwork
 - 15. Proper service and access clearances
 - 16. Proper installation of filters
 - 17. Filter gauges set to zero
- C. Casing leakage testing validating that the AHU casing after assembly and installation meets the requirements of Article 2.2 – Unit Casings.
 - 1. A field casing leakage test performed by the factory technician in accordance with AHU factory standards listed within this specification shall occur and shall be witnessed by the owner or designated representative.
 - 2. The casing leakage test shall be considered successful when the specified leakage rate is achieved for a steady-state 2-hour period at the specified pressure rating.
 - 3. The pressure test shall be repeated if remedial measures are necessary to achieve the specified leakage rate for the unit.
 - 4. Resolve any non-compliant items prior to proceeding with the specified Startup Services per section 3.03.

5. Prepare field casing leakage test and inspection reports.
- D. Final Acceptance Requirements:
 1. Use dial indicator gauges to demonstrate fan and motor are aligned.
 2. Verify conformance to specifications using vibration analysis.
 3. Maximum Vibration Levels:
 - a. 0.075 inch per second at 1 times run speed and at fan/blade frequency.
 - b. 0.04 inch per second at other multiples of run speed.
- E. Coordination of Other Tests and Inspections:
 1. State of Delaware OMB - Division of Facilities Management will employ independent Testing, Adjusting, and Balancing agency to test and/or inspect the air handling-unit.

3.04 SYSTEM STARTUP

- A. Provide manufacturer's field representative to instruct systems startup.
- B. Prepare and start equipment and systems in accordance with manufacturers' instructions and recommendations.
- C. Adjust for proper operation within manufacturer's published tolerances.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 78 00 - Closeout Submittals, for closeout submittals.
- B. See Section 01 79 00 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate operation of system to State of Delaware OMB - Division of Facilities Management's personnel.
 1. Use operation and maintenance data as reference during demonstration.
 2. Conduct walking tour of project.
 3. Briefly describe function, operation, and maintenance of each component.
- D. Training: Train State of Delaware OMB - Division of Facilities Management's personnel on operation and maintenance of system.
 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 2. Manufacturer shall include a minimum of five (5) man days and one (1) trip for start-up and owner maintenance training and orientation.
 3. Instructor: Manufacturer's training personnel.
 4. Location: At project site.

3.06 COMMISSIONING AND DEMONSTRATION

- A. Coordinate with the Owner's CxA related to the HVAC Commissioning Requirements specified in Section 018150 – General Commissioning and 230800 – Commissioning of HVAC.
- B. Engage a factory-trained and factory-employed service representative to adjust and operate the ERU during Commissioning activities (startup, checkout, and troubleshooting during functional performance testing). Factory representative must be knowledgeable of the equipment and systems and capable of assisting with troubleshooting and making unit adjustments as required to support the owner's commissioning process.

3.07 CLEANING

- A. Install temporary construction filters during construction, testing, commissioning period prior to receiving substantial completion from the Owner. Contractor shall replace construction filters prior to substantial completion to maintain system operation (i.e., low pressure loss across filters). Upon receiving substantial completion from the Owner, replace construction filters with specified filters at Substantial Completion.

- B. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

END OF SECTION