



STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
800 BAY ROAD
P.O. BOX 778
DOVER, DELAWARE 19903

JENNIFER COHAN
SECRETARY

VIA WEBSITE POSTING AND OVERNIGHT DELIVERY

January 17, 2020

Contract No. T201880102.01
Bear Administration Building - Demolition and Reconstruction
New Castle County

Ladies and Gentlemen:

Enclosed is Addendum No. 2 for the referenced contract consisting of the following:

1. **The date for the receipt of bids has been moved to Tuesday, February 11, 2020, prior to 2:00 p.m.**
2. The Bid Proposal Cover, revised, to be substituted for the same page in the Proposal.
3. Two (2) pages, Appendix A, Table of Contents, pages TOC-1 and TOC-2, revised, to be substituted for the same pages in the Appendix.
4. Seven (7) pages, Appendix A, Technical Specifications, Section 018155 Air Barrier System Testing, pages 018155-1 through 018155-7, has been deleted from the Appendix.
5. Thirteen (13) pages, Appendix A, Technical Specifications, Section 019113 Commissioning General Requirements, pages 019113-1 through 019113-13, has been added to the Appendix.
6. Three (3) pages, Appendix A, Technical Specifications, Section 072726 Fluid Applied Membrane Air Barriers, pages 072726-6 through 072726-8, revised, to be substituted for the same pages in the Appendix.
7. Ten (10) pages, Appendix A, Technical Specifications, Section 075419 - Polyvinyl-Chloride (PVC) Roofing,, pages 075419-1, and 075419-6 through 075419-14, revised, to be substituted for same pages in the Appendix.
8. Four (4) pages, Appendix A, Technical Specifications, Section 079200 - Joint Sealants, pages 079200-7 through 079200-10, revised, to be substituted for the same pages in the Appendix.
9. Four (4) pages, Appendix A, Technical Specifications, Section 084113 - Aluminum Frame Entrances and Storefronts, pages 084113- 10 through 084113-13, revised, to be substituted for the same pages in the Appendix.
10. One (1) page, Appendix A, Technical Specifications, Section 084413 Glazed Aluminum Curtain Walls, page 084413-11, revised, to be substituted for the same page in the Appendix.
11. Two (2) pages, Appendix A, Technical Specifications, Section 086300 Metal Framed Skylights, pages 086300-7 through 086300-8 , revised, to be substituted for the same pages in the Appendix.
12. Six (6) pages, Appendix A, Technical Specifications, Section 101423.16 Room-Identification Panel Signage, pages 101423.16-1 through 101423.16-6, has been added to the Appendix.
13. One (1) page, Appendix A, Technical Specifications, Section 142400 Hydraulic Elevators, page 142400-3, revised, to be substituted for the same pages in the Appendix.
14. One (1) page, Appendix A, Technical Specifications, Section 235216 Condensing Boilers, page 235216-3, revised, to be substituted for the same page in the Appendix.

15. One (1) page, Appendix A, Technical Specifications, Section 284621.11 Addressable Fire-Alarm Systems, page 284622.11-13, revised, to be substituted for the same page in the Appendix.
16. Fifteen (15) sheets, Construction Plans, sheets A311, A312, A-313, A-314, A-315, A-401, A-402, A-501, A-502, A-504, A-505, A-506, A-611, A-701 and A-711, revised, to be substituted for the sheets in the Plans.

These sheets will not be displayed on the website. A determination has been made that the publication of these specific plans could compromise public safety and are not available pursuant to Delaware Code, Title 29, §10002 (1)(17)(a)(2) and (3).

Please note the revisions listed above and submit your bid based upon this information.

Sincerely,

~signature on file~

Connie Ivins
Competitively Bid Contracts Coordinator
Delaware Department of Transportation

STATE OF DELAWARE



DEPARTMENT OF TRANSPORTATION

BID PROPOSAL

for

CONTRACT T201880102.01

**BEAR ADMINISTRATION BUILDING
DEMOLITION AND RECONSTRUCTION**

NEW CASTLE COUNTY

ADVERTISEMENT DATE: December 9, 2019

COMPLETION TIME: 677 Calendar Days

**PROSPECTIVE BIDDERS ARE ADVISED THERE WILL BE A MANDATORY PRE-BID MEETING:
MONDAY JANUARY 6, 2020 AT 11:00 A.M. IN THE BEAR ADMINISTRATION BUILDING,
250 Bear-Christiana Road, Bear, DE 19701**

SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION
DELAWARE DEPARTMENT OF TRANSPORTATION
AUGUST 2016

Bids will be received in the Bidder's Room at the Delaware Department of Transportation's Administration Building, 800 Bay Road, Dover, Delaware prior to 2:00 P.M. local time ~~THURSDAY JANUARY 23~~
TUESDAY, FEBRUARY 11, 2020

Bear Administration Building

This specification is for the work associated with the Canal District Administration Building.

<u>SECTION</u>	<u>SECTION TITLE</u>
<u>DIVISION 01</u>	
<u>GENERAL REQUIREMENTS</u>	
011000	Summary
012600	Contract Modification Procedures
012900	Payment Procedures
013100	Project Management and Coordination
013300	Submittal Procedures
014000	Quality Requirements
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017823	Operation and Maintenance Data
017839	Project Record Documents
018155	Air Barrier System Testing
018200	Demonstration and Training
019113	Commissioning General Requirements
<u>DIVISION 03</u>	
<u>CONCRETE</u>	
033000	Cast-In-Place Concrete
<u>DIVISION 04</u>	
<u>MASONRY</u>	
042200	Unit Masonry
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<u>METALS</u>	
051200	Structural Steel Framing
053100	Steel Decking
054000	Cold-Formed Metal Framing
055000	Metal Fabrications
055113	Metal Pan Stairs
<u>DIVISION 06</u>	
<u>WOOD, PLASTICS, AND COMPOSITES</u>	
061053	Miscellaneous Rough Carpentry
061600	Sheathing
064116	Plastic-Laminate-Clad Architectural Cabinets

DIVISION 07

THERMAL AND MOISTURE PROTECTION

071616	Crystalline Waterproofing
072100	Thermal Insulation
072726	Fluid-Applied Membrane Air Barriers
074293	Soffit Panels
074646	Fiber-Cement Siding
075419	Polyvinyl-Chloride (PVC) Roofing
076200	Sheet Metal Flashing and Trim
078413	Penetration Firestopping
078443	Joint Firestopping
079200	Joint Sealants

DIVISION 08

OPENINGS

081113	Hollow Metal Doors and Frames
081216	Aluminum Frames
081416	Flush Wood Doors
084113	Aluminum-Framed Entrances and Storefronts
084413	Glazed Aluminum Curtain Walls
086300	Metal-Framed Skylights
087100	Door Hardware
088000	Glazing
088813	Fire-Rated Glazing

DIVISION 09

FINISHES

092216	Non-Structural Metal Framing
092900	Gypsum Board
093013	Ceramic Tiling
095113	Acoustical Panel Ceilings
096513	Resilient Base and Accessories
096519	Resilient Tile Flooring
096813	Tile Carpeting
099113	Exterior Painting
099123	Interior Painting

DIVISION 10

SPECIALTIES

101419	Dimensional Letter Signage
101423.16	Room-Identification Panel Signage
102113.14	Stainless-Steel Toilet Compartments
102239	Folding Panel Partitions
102800	Toilet, Bath, and Laundry Accessories
104413	Fire Protection Cabinets and Extinguishers
107516	Flagpoles

SECTION 018155

AIR BARRIER SYSTEM TESTING

PART 1 - GENERAL

1.1 SUMMARY

- A. The air barrier shall be contiguous and connected across the six surfaces of the enclosed air barrier envelope indicated. Inspection and testing services are required to verify compliance with requirements specified or indicated. Perform building inspections, thermography and air barrier leakage tests to demonstrate that the air barrier materials are properly installed and joined; that windows, doors, dampers, and ducts are sufficiently air tight and that the overall air barrier envelope is sealed. The quality of the construction of the air barrier systems, including the joining and sealing of the air barrier materials and accessories must be sufficient to limit leakage under pressure to the maximum leakage functional requirements outlined in this specification.
- B. Passing an air barrier leakage test and thermography test to demonstrate that the building envelope is properly sealed and insulated will result in system acceptance. Report the results of the thermograph and leakage tests. The testing and reporting shall be performed in accordance with the procedures outlined in this specification.

1.2 DEFINITIONS

- A. The following terms as they apply to this section.
 - 1. Air Barrier Accessory: Products designated to maintain air tightness between air barrier materials, air barrier assemblies and air barrier components, to fasten them to the structure of the building, or both (e.g., sealants, tapes, backer rods, transition membranes, fasteners, strapping, primers).
 - 2. Air Barrier Assembly: The combination of air barrier materials and air barrier accessories that are designated and designed within the environmental separator to act as a continuous barrier to the movement of air through the environmental separator.
 - 3. Air Barrier Component: Pre-manufactured elements such as windows, doors and service elements that are installed in the environmental separator.
 - 4. Air Barrier Material: A building material that is designed and constructed to provide the primary resistance to airflow through an air barrier assembly.
 - 5. Air Barrier System: The combination of air barrier assemblies and air barrier components, connected by air barrier accessories that are designed to provide a continuous barrier to the movement of air through an environmental separator. This includes the roof, wall, and floor assemblies, and the wall and roof components, and may include interior walls or partitions. There may be more than one air barrier system in a single building.
 - 6. Air Leakage Rate: The rate of airflow (CFM) driven through a unit surface area (sq. ft.) of an assembly or system by a unit static pressure difference (in.w.g or

Pa) across the assembly. (examples: CFM/sq. ft. @ 0.30 in.w.g, or CFM/sq. ft. @ 75 Pa).

7. Air Permeance: The rate of airflow (CFM) through a unit area (sq. ft.) of a material driven by unit static pressure difference (in.w.g. or Pa) across the material.
8. Environmental Separator: The parts of a building that separate the controlled interior environment from the uncontrolled exterior environment, or that separate spaces within a building that have dissimilar environments.
9. Test Zone: The portion of or volume within a building enclosed by an air barrier system which is to be tested for air leakage. The test zones are indicated.

1.3 PRECONSTRUCTION CONFERENCE

- A. Organize pre-construction conferences between the air barrier inspector and the sub-contractors involved in the construction of or penetration of the air barrier system to discuss where each sub-contractor begins and ends the sequence of installation, and each sub-contractor's responsibility to ensure airtight joints, junctures, penetrations and transitions between materials, products, and assemblies of products specified in the different sections to be installed by the different sub-contractors.

1.4 SUBMITTALS

A. Samples:

1. Mock-up: build one as specified prior to building construction.

B. Certificates

1. Air Barrier Inspector: Two copies 30 days after Notice to Proceed.
2. Thermography Test Firm: Two copies 60 days prior to thermography testing.
3. Thermography Test Technician: Two copies 60 days prior to thermography testing.
4. Air Barrier Leakage Test firm: Two copies 60 days prior to Leakage testing.
5. Air Barrier Leakage Test Technician: Two copies 60 days prior to leakage testing.

C. Test Reports

1. Thermography Test Procedures: Two copies 30 days prior to thermographic testing/examination.
2. Building Air Barrier Leakage Test Procedures: Two copies of detailed test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the Building Air Barrier Leakage Test 30 prior to leakage testing.
3. Thermographic Test Report: Two copies of interim reports 10 days after completion. Four copies of the final report 14 days after completion.
4. Air Barrier Leakage Test Report: Two copies of interim reports 10 days after completion. Four copies of the final report 14 days after completion.

1.5 AIR BARRIER SYSTEM FUNCTIONAL REQUIREMENTS

- A. The air leakage of the entire building shall not exceed 0.4 cfm/ft² under a pressure differential of 0.3 in. water (1.57psf) (2.0 L/s.m² @ 75 Pa) when tested according to ASTM E 779.

1.6 QUALITY CONTROL

A. Qualifications

1. Air Barrier Inspector: Two years' experience in the installation of air barrier materials and assemblies including the experience in joining and sealing various components and sealing of penetrations of air barriers. Experience coordinating and instructing personnel involved in the installation, joining, and sealing of air barrier materials and components.
2. Thermography Test Firm: Minimum 2 years' experience in thermographic testing and analysis, with a minimum of 3 successful projects of similar type and scope in the previous 3 years, using the specified testing standard, and employing qualified test technicians under the supervision of a Level III Certified Infrared Thermographer.
3. Thermography Test Technician: Possess Level II Training and Certification from a firm whose training and certification program complies with the recommended practice established by ASNT SNT-TC-1A and ASNT CP-105. Possess a certificate indicating successful completion of a course and examination specifically related to building envelope thermography. Document demonstration of 2 years' experience in infrared thermography testing including interpreting and reporting findings in accordance with the requirements of ASTM C1060.
4. Air Barrier Leakage Test Firm: Minimum 2 years' experience in air tightness testing and analysis of commercial buildings, with a minimum of 3 successful projects of similar type and scope in the previous 3 years, using the specified testing standard, and employing qualified test technicians.
5. Air Barrier Leakage Test Technician: Two years' experience in air tightness testing of commercial buildings using the specified testing standard and equipment.

PART 2 - PRODUCTS (not used)

PART 3 - EXECUTION

3.1 QUALITY CONTROL

- A. Documentation and Reporting: Document the entire installation process on daily job site reports. These reports include information on the Installer, substrates, substrate preparation, products used, ambient and substrate temperature, the location of the air barrier installation, the results of the quality control procedures, and testing results.
- B. Construction Mock-Up:

1. Prepare a construction mock-up to demonstrate proper installation of the air barrier. The mock-up shall include air barrier connections between floor and wall, wall and window, wall and roof. The mock-up shall include the sealing method between membrane joints at transitions from one material or component to another, at pipe or conduit penetrations of the wall and roof, and at duct penetration of the wall and roof. Work will not begin until the mock-up is satisfactory to the Air Barrier Leakage Test Firm, Air Barrier Inspector and Architect.
2. The mock-up shall be approximately 8 feet long by 8 feet high. The mockup shall be representative of primary exterior wall assemblies and glazing components including backup wall and typical penetrations as acceptable to the Air Barrier Leakage Test Firm, Air Barrier Inspector and Architect.

3.2 REPAIR AND PROTECTION

- A. Upon completion of inspection, testing, sample taking and similar services, repair damaged construction and restore substrates and finishes.
- B. Protect construction exposed by or for quality-control service activities and protect repaired construction.
- C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for inspection, testing, or similar services.
- D. Quality Control Testing: Conduct the following qualitative and quantitative tests and inspections during installation of the air barrier system.
 1. Qualitative Testing and Inspection:
 - a. Provide daily report of observations for each site visit, with copies to the Owner, Contractor and Architect.
 - b. Ensure continuity of the air barrier system throughout the building enclosure and that gaps are covered, the covering is structurally sound, and all penetrations are sealed allowing for no infiltration or exfiltration through the air barrier system.
 - c. Ensure structural support of the air barrier system to withstand design air pressures.
 - d. Ensure masonry and concrete surfaces receiving air barrier system are smooth, clean and free of cavities, protrusions and mortar droppings, with mortar joints struck flush or as required by the manufacturer of the air barrier material.
 - e. Ensure site conditions for application temperature and dryness of substrates are within guidelines.
 - f. Ensure maximum length of exposure time of materials to ultra-violet deterioration is not exceeded.
 - g. Ensure surfaces are properly primed.
 - h. Ensure laps in material are 2" minimum, shingled in the correct direction (or mastic applied on exposed edges), with no fish-mouths.
 - i. Ensure that mastic is applied on cut edges.

- j. Ensure that a roller has been used to enhance adhesion.
- k. Measure application thickness of liquid-applied materials to manufacturer's specifications for the specific substrate.
- l. Ensure that correct materials used for compatibility.
- m. Ensure proper transitions at changes in direction, and structural support at gaps.
- n. Ensure proper connections between assemblies (membrane and sealants) for cleaning, preparation and priming of surfaces, structural support, integrity and continuity of seal.
- o. Ensure all penetrations are sealed.
- p. ASTM E 1186 "Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Retarder Systems."
 - 1) Infrared scanning with pressurization/depressurization.
 - 2) Smoke pencil with pressurization/depressurization.
 - 3) Pressurization/depressurization with use of anemometer
 - 4) Generated sound with sound detection
 - 5) Tracer gas measurement of decay rate
 - 6) Chamber pressurization/depressurization in conjunction with smoke tracers
 - 7) Chamber depressurization using detection liquids

2. Quantitative tests:

- a. Provide written test reports of all tests performed, with copies to the Owner, Contractor and Architect.
- b. Material compliance for maximum air permeance, ASTM E 2178.
- c. ASTM E 283, Determining rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors under Specified Pressure Differences Across the Specimen.
- d. Assemblies, ASTM E 2357, test pressure and allowable air leakage rate to be determined by design professional for interior design conditions and location of project.
- e. CAN/CGSB 1986 Standard 149.10, Determination of the Airtightness of Building Envelopes by the Fan Depressurization Method.
- f. CAN/CGSB 1996 Standard 149.15 Determination of the Overall Envelope Airtightness of Office Buildings by the Fan Depressurization Method Using the Building's Air Handling System.
- g. Whole building, floors, or suites, ASTM E779, Determining Airtightness of Buildings Air Leakage Rate by Single Zone Air Pressurization.
- h. Windows and connections to adjacent opaque assemblies, ASTM E783 method B
- i. Tracer gas testing, ASTM E741
- j. Pressure test, ASTM E330
- k. Determine the bond strength of coatings to substrate in accordance with ASTM D4541.

3.3 THERMOGRAPHY TEST

- A. Upon completion of construction, and completion of quality control measures for the air barrier system and the thermal envelope, infrared thermography tests shall be conducted.
1. Field Conditions: Perform testing under conditions stipulated in test standards, in instrument manufacturer's instructions, and in this Section. Perform testing on dry building surfaces after sunset and prior to sunrise .
 2. Thermography Test Procedures: The building envelope shall be tested using Infrared Thermography technology. The thermography testing shall be completed in accordance with the requirements of ASTM C1060 and ISO 6781. Perform a complete thermographic inspection consisting of full exterior and interior inspection of the complete thermal envelope and air barrier system. Note areas of the envelope that the inspection cannot cover due to limited or no access. The Owner and Architect shall be given the opportunity to witness the testing. Conduct testing just before the Building Air Barrier Leakage Test. Also, conduct testing during the Building Air Barrier Leakage Test so that air leaks are detected. If the building air barrier leakage test is failed, Thermographic testing shall be repeated just before and during subsequent air barrier leakage tests until the leakage test is successful. Address the cause and required corrective action for all anomalous thermal images resulting from the examination. Submit detailed test procedures indicating the test apparatus, the test methods and procedures, and the analysis methods to be employed for the Thermography Test.
 3. Thermographic Test Report: Include thermographs in color and a color temperature scale to define the temperature indicated by the various colors. Identify the high temperature reading, the outdoor air temperature, the building indoor air temperature, and the wind speed and direction. Note any areas of compromise in the building envelope, and note all actions required and taken to correct those areas. Final thermography test report shall demonstrate that the problem areas have been corrected. Submit the complete test and analysis.

3.4 AIR BARRIER LEAKAGE TEST

- A. Upon completion of construction, and quality control measures for the air barrier system, building air barrier leakage tests shall be conducted.
1. Building Air Barrier Leakage Test Procedures: Perform the air leakage test in accordance with ASTM E779.
 2. Fan Pressurization Test: Conduct the fan pressurization test to determine final compliance with the air barrier system functional requirement when all components of the air barrier system have been installed and inspected, and have passed any intermediate testing procedures. The test may be conducted before finishes that are not part of the air barrier system have been installed. For example, if suspended ceiling tile, interior gypsum board, or cladding systems are not part of the air barrier system, the test may be conducted before they are installed.
 3. Air Barrier Leakage Test Report: Submit a certified written report of each inspection, test, or similar service. Written reports of each inspection and test or

similar service shall include all the Report items described in ASTM E1827. Additionally, the report shall also include the following information:

- a. Date of Issue
- b. Project title and number
- c. Name, address, and telephone number of testing agency
- d. Dates and locations of samples and tests or inspections
- e. Names of individuals making the inspection or test
- f. Designation of the Work and test method
- g. Identification of product and Specification Section
- h. Complete inspection or test data
- i. Test results and an interpretation of test results for each test zone
- j. Name and signature of laboratory inspector
- k. Recommendations on retesting
- l. Comments or professional opinion on whether inspected or tested work complies with Contract Document requirements

3.5 AIR BARRIER FUNCTIONAL REQUIREMENTS FAILURE

- A. If the final air barrier test indicates that the leakage of the constructed air barrier system exceeds the maximum leakage specified, coordinate with the Designer of Record, the subcontractors, and the Owner to immediately determine the cause of the failure, develop a method to change or repair the air barrier system. Then, develop and schedule a re-test of the air barrier system. Repeat until the air barrier system test is passed.

3.6 REPAIR AND PROTECTION

- A. Upon completion of inspection, testing, or sample taking and similar services, repair damaged construction and restore substrates and finishes, protect construction exposed by or for quality control service activities, and protect repaired construction.

END OF SECTION

SECTION 019113
COMMISSIONING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SECTION INCLUDES

- A. The work under this section is subject to requirements of the Contract Documents, including the Owner's General Conditions and articles of the General Contractor's General Conditions.
- B. This section includes the commissioning requirements for the Building Enclosure systems.
 - 1. The commissioning requirements for the Building Enclosure systems given in this Section are entirely separate from, and in addition to, the General Commissioning Requirements for this project. The General Contractor (GC), Subcontractors, and Suppliers are required to participate in both commissioning processes as required along with any supplemental General Commissioning requirements.
 - 2. The Commissioning Authority and Building Enclosure Commissioning Agent will provide separate documentation for each commissioning process.
- C. This section includes the Building Enclosure Commissioning requirements and the Functional Performance Testing Requirements for the building enclosure systems.

1.3 GENERAL DESCRIPTION

- A. Building Enclosure Commissioning (BECx) is a systematic process of ensuring all building enclosure systems responsible for environmental separation perform interactively according to the Owner's Project Requirements (OPR) and the Architect's Basis of Design (BOD). The BECx process is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify and document proper installation and performance of building enclosure materials and systems.
 - 2. Provide Owner with functional building enclosure systems that meet the OPR.
- B. Commissioning does not take away from, or reduce the responsibility of, system designers or installing contractors to provide a finished and fully functioning product.

- C. This Section shall in no way diminish the responsibility of Division 03, 04, 07, 08, and 09 Contractors, Subcontractors, and Suppliers in performing all aspects of work and testing as outlined in the Contract Documents. Any requirements outlined in this Section are in addition to requirements outlined in Division 03, 04, 07, 08, and 09.

1.4 RELATED WORK AND DOCUMENTS

- A. Specific building enclosure commissioning requirements are provided in this Specification. The following Specification Sections are related to the commissioning work specified in this Section:
 - 1. General Commissioning Requirements: *Refer to Section 01 91 13*
 - 2. Concrete Requirements: *Refer to Division 03*
 - 3. Masonry Requirements: *Refer to Division 04*
 - 4. Thermal and Moisture Protection Requirements: *Refer to Division 07*
 - 5. Openings Requirements: *Refer to Division 08*
 - 6. Finish Requirements: *Refer to Division 09*
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 Specification Sections, apply to this Section. Division 3, 4, 7, 8, and 9 Specification Sections also apply to this Section. Where conflicts arise regarding building enclosure testing, this Section shall supersede other Sections where contradictions occur.

1.5 ABBREVIATIONS

- A. The following are common abbreviations used in this Section:
 - 1. A/E – Architect and Design Engineers
 - 2. BECx – Building Enclosure Commissioning
 - 3. BECxA – Building Enclosure Commissioning Agent
 - 4. BOD – Basis of Design
 - 5. CxA – Commissioning Authority – *Refer to Section 01 91 13*
 - 6. GC – General Contractor
 - 7. CT – Commissioning Team
 - 8. Cx – Commissioning
 - 9. Cx Plan – Commissioning Plan
 - 10. FPT – Functional Performance Test
 - 11. OPR – Owner’s Project Requirements
 - 12. OR – Owner’s Representative
 - 13. O&M – Operations & Maintenance
 - 14. RFI – Request for Information
 - 15. BECxT – Building Enclosure Commissioning Testing Agency
 - 16. QA – Quality Assurance
 - 17. QC – Quality Control
 - 18. MFG – Manufacturer

1.6 DEFINITIONS

- A. Approval: Acceptance that a material or system has been properly installed and is functioning in tested modes according to the Contract Documents.
- B. Architect/Engineer (A/E): Prime consultant (architect) and sub-consultants who comprise the design team, generally the Architect of Record and any Design Sub-consultants.
- C. Basis of Design (BOD): Documentation of primary thought processes and assumptions behind design decisions made to meet design intent. Describes systems, components, conditions, and methods chosen to meet the OPR.
- D. Building Enclosure Commissioning Agent (BECxA): Contracted through the Owner. The BECxA directs and coordinates day-to-day building enclosure commissioning activities independently from CxA.
- E. Commissioning Authority (CxA): Contracted to Owner. CxA directs and coordinates day-to-day commissioning activities excluding BECx activities. CxA reports directly to Owner.
- F. Commissioning Plan (Cx Plan): Overall plan developed after bidding that provides structure, schedule, and coordination planning for commissioning process. The BECx plan will be provided separately from other Cx plans.
- G. Contract Documents: Documents binding on parties involved in construction of this project (e.g. drawings, specifications, change orders, amendments, contracts, etc.).
- H. Deficiency: Condition of a building enclosure material or system that is not in compliance with Contract Documents (i.e. does not perform properly or is not complying with design intent).
- I. Functional Performance Test (FPT): Test of installed (either mock-up or field) building enclosure materials and systems. Systems are tested under various simulated environmental conditions.
- J. Owner's Project Requirements (OPR): A written document that details the functional requirements of a project and the usage and operational expectations. This includes project and design goals, measurable performance criteria, budgets, schedules, success criteria, and supporting information.
- K. Simulated Condition: Condition created for testing a component or system (e.g., applying pressure differential across the building enclosure concurrent with water spray to simulate a wind-driven rain).
- L. Specifications: Construction specifications of Contract Documents.
- M. Mock-up: The activities where systems or materials are initially constructed and tested. Mock-ups are to be free standing (separate from the building) and approved prior to commencing full-scale construction.

- N. First Installation Mock-up: The activities where systems or materials are initially constructed and tested on the building. First installation mock-ups must be approved prior to commencing full-scale construction.
- O. Sub-contractor: Contractors of GC, and their Sub-contractors, who provide and install building enclosure components and systems.

1.7 COORDINATION

- A. Commissioning Team: Members of the Commissioning Team (CT) will consist of:
 - 1. Commissioning Authority (CxA)
 - 2. Building Enclosure Commissioning Agent (BECxA)
 - 3. Building Enclosure Commissioning Testing Agency (BECxT)
 - 4. Owner's Representative(s) (OR)
 - 5. General Contractor (GC)
 - 6. Architect and Design Engineers (A/E)
 - 7. Building Enclosure Subcontractors
- B. Management: Owner will contract services of the BECxA and BECxT through the CxA. The BECxA will direct and coordinate commissioning activities and report to the OR. All members of the Commissioning Team shall cooperate to fulfill contracted responsibilities and objectives of the Contract Documents.
- C. Scheduling:
 - 1. BECxA will work with commissioning team to establish required commissioning activities to incorporate in preliminary commissioning schedule. The GC will integrate commissioning activities into master construction schedule. Necessary notifications are to be made in a timely manner in order to expedite commissioning.

1.8 SUBMITTALS

- A. A/E or General Contractor shall provide BECxA with documentation required for commissioning work. At minimum, documentation shall include: General Commissioning Requirements and performance data and any performance test procedures. BECxA shall review submittals concurrent with the A/E for conformance as it relates to commissioning.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 SYSTEMS TO BE COMMISSIONED

A. Building Enclosure

1. Below Grade Systems, Roofing Systems, Opaque Wall/Cladding Systems, Weather Resistive Barrier Systems, Fenestration Systems, and all other systems responsible for providing the following building enclosure functions:
 - a. Water Control
 - b. Air Control
 - c. Vapor Control
 - d. Thermal Control

3.2 RESPONSIBILITIES OF COMMISSIONING TEAM MEMBERS DURING CONSTRUCTION PHASE

A. Architect/Engineer (A/E)

1. Document design intent of systems.
2. Review and incorporate building enclosure commissioning specification which includes functional performance test requirements into the construction documents.
3. Provide construction documents electronically.
4. Review BECxA comments on construction documents and shop drawings.
5. Assist in dispute resolution regarding building enclosure items.
6. Review BECxA and BECxT reports.

B. Building Enclosure Commissioning Agent (BECxA)

1. Review and comment on the Design Intent and Basis of Design for the project and assist in creating the Owner's Project Requirements (OPR) document for the building enclosure after the initial kick-off meeting with the project team.
2. Review and comment on all Design Development and other pertinent documents, including the energy model, glazing report, and other reports related to the building enclosure.
3. Review and comment on cost estimates prepared by the Construction Manager when requested.
4. Contribute to the design of enclosure systems, details, and materials selection.
5. Develop and submit the Building Enclosure Commissioning Plan, coordinating the Plan with the CxA and the rest of the team.
6. Develop Enclosure Commissioning specification which includes requirements for Functional Performance Testing for building enclosure systems for incorporation into the project documents.

7. Develop and maintain an Enclosure Design Issues Log, documenting identified issues, responses, and resolution.
8. Attend regularly scheduled meetings/conference calls/web-based interfaces (when contracted to do so) at milestones appropriate for the complexity of the project and to maintain schedule milestones.
9. Provide technical reviews of the Construction Documents.
10. Conduct a BECx kick-off meeting with the Owner, Design Team, Construction Manager, and Subcontractors, including preparing meeting minutes.
11. Review construction sequencing and verify material assembly and compatibility through shop drawings and project submittals. BECx review of the shop drawings and submittals pertinent to the building enclosure will be conducted prior to, or in conjunction with, the review by the Design Team. The Design Team will have the ability to incorporate the BECx review comments for approval.
12. Review and comment on enclosure related RFIs, bulletins, and change order proposals.
13. Review proposed substitutions and value engineering.
14. Review and document construction of the mock-up against the design documents, shop drawings, recommended manufacturer's installation instructions, and the industry accepted standard of care. All mock-up testing will be witnessed and documented, and BECx will provide assistance for diagnosing performance problems. At the completion of the mock-up, BECx will assemble their notes, photos, sketches, manufacturer's details, project information and design changes into a mock-up manual that will be distributed to the project team. This manual is intended to define the standard of care demonstrated in the mock-up for use on the remainder of the project.
15. Review and comment on construction scheduling and sequencing.
16. Lead a pre-installation conference for building enclosure trades and issue meeting minutes to the project team. During the meeting, BECx will review trade sequencing, ownership, constructability, and compatibility of work.
17. Verify and document field QA/QC tasks, perform site visits, and track the progress of resolving on-going deficiency list items. During the QA site visits, BECx will review the exterior enclosure for conformance to the design documents, shop drawings, recommended manufacturer's installation instructions, and the industry accepted standard of care. The BECx reporting system is to individually track each condition observed in the field with the intent on completing the project with no unaddressed items.
18. Update the BECx plan throughout the construction phase, as required. BECx will also integrate RFIs and change orders into the BECx plan and coordinate BECx plan items with relevant parties.
19. Observe and witness functional performance testing and retesting by others. BECx will attempt to schedule test observations during site inspection visits. The BECx will prepare and distribute written and illustrated reports to the project team including concerns and recommendations.
20. Prepare a draft and final commissioning report of all work and final acceptance.
21. Review as-built drawings and O&M manuals.
22. Visit the site approximately 10 months post occupancy to review the performance and observe the condition of the exterior building elements. Upon completion of this site visit the BECx will update the final commissioning report.

C. General Contractor (GC)

1. Attend all commissioning meetings.
2. Incorporate commissioning activities into the construction schedule.
3. Periodically update commissioning activities in the construction schedule.
4. Facilitate cooperation of Sub-contractors in commissioning work.
5. Submit copies of initial and final A/E approved submittals for commissioned systems to BECxA for review.
6. Review BECxA submittal comments
7. Verify building enclosure materials and assemblies are ready for functional performance testing.
8. Submit maintenance logs of all interim maintenance and/or repair tasks performed by Sub-contractors.
9. Ensure resolution of non-compliance and deficiencies in construction and/or test results. Obtain written documentation of completion from the appropriate Sub-contractors.
10. Provide letters of compatibility for adjacent building enclosure materials and assemblies.
11. Facilitate all repairs and retesting of failed condition(s) and pay for all associated costs.
12. Provide all warrantee information to BECxA.

D. Subcontractors/Vendors

1. Review BECx Plan.
2. Attend commissioning kick-off meeting and other commissioning team meetings.
3. Notify GC and BECxA of work completion.
4. Attend all required material and systems testing.
5. Execute all periodic maintenance and/or repairs as required on systems from initial mock-up to final acceptance by Owner to prevent material warranties from being voided.
6. Ensure installation work is complete, is in compliance with Contract Documents, and is ready for Functional Performance Testing. Notify GC that systems are ready for Functional Performance Testing.
7. Provide all warrantee information to GC.

E. Building Enclosure Commissioning Testing Agency (BECxT)

1. Attend commissioning kick-off meeting and other commissioning team meetings.
2. Provide on-site technician and equipment to complete Functional Performance Testing.
3. Prepare and submit reports at the conclusion of all testing.
4. Perform retesting and prepare corresponding reports.

3.3 DOCUMENTATION, NON-CONFORMANCE, AND APPROVAL OF TESTS

A. Documentation

1. BECxA will summarize the results of FPT.
2. BECxT will perform and report results of FPT as required by the specified standard.
3. BECxA will provide status reports to GC, A/E, and Owner as needed.
4. BECxA shall provide a final summary report to Owner.

B. Non-Conformance

1. BECxT shall submit all test reports to the BECxA, GC, CxA, A/E and Owner as needed.
2. Corrections of minor deficiencies identified may be made during tests at discretion of BECxA. In such cases, deficiency and resolution will be documented.
3. Every effort will be made to expedite testing and minimize unnecessary delays, while not compromising integrity of tests. BECxA shall not overlook deficient work or loosen acceptance criteria to satisfy scheduling or cost issues unless directed to do so by the Owner.
4. Deficiencies are handled in the following manner:
 - a. When there is no dispute about a deficiency and Sub-contractor accepts responsibility for remedial action:
 - i. BECxA documents deficiency and Sub-contractors' response and intentions and they go on to another test or installation. BECxA submits deficiency report to GC, CxA and Owner. Copy is provided to Sub-contractor by GC. Sub-contractor corrects deficiency and certifies that material or assembly is ready to be retested. GC informs CT of retesting schedule.
 - ii. GC reschedules test with BECxA/ BECxT.
 - b. When there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible:
 - i. BECxA documents deficiency and Contractor's response. BECxA submits deficiency report to GC, CxA and Owner. Copy is provided to Sub-contractor by GC.
 - ii. GC facilitates resolution of deficiency. Other parties are brought into discussions as needed. Final interpretive authority is with A/E. Final acceptance authority is with the Owner.
 - iii. GC documents resolution process.
 - iv. Once interpretation and resolution have been decided, appropriate party corrects deficiency, GC reschedules test, and test is repeated until satisfactory performance is achieved.

C. Cost of Testing

1. Costs for the initial testing located within this specification shall be the responsibility of the contractor. The contractor is to provide access to the test specimens to the CT. Access may include, but is not limited to, hoists, scaffolding, swing stage, extended lifts, etc.

D. Cost of Retesting

1. Costs for all retesting will be the full responsibility of the GC and Sub-contractors. These costs include all access, equipment, labor, and materials required to complete the retesting.

3.4 FUNCTIONAL PERFORMANCE TESTING

A. Objectives and Scope:

1. The objective of Functional Performance Testing is to demonstrate each system is operating according to documented design intent and Contract Documents. Functional Performance Testing facilitates bringing systems from a state of substantial completion to fully operational. Additionally, during Functional Performance Testing, areas of deficient performance are identified and corrected, improving operation and functioning of systems.

B. Development of Test Procedures

1. The purpose of a specific test is to verify and document compliance of the installed enclosure systems with the OPR.

C. Coordination and Scheduling

1. GC will provide sufficient notice to BECxA regarding completion schedule for materials and systems. GC will schedule Functional Performance Tests with CT. BECxA shall witness and document functional testing of enclosure systems. BECxT shall execute tests under direction of BECxA.

D. Field Functional Performance Testing Requirements

1. All functional performance tests shall be conducted to project performance requirements as set forth herein and within the Construction Documents. Unless specifically noted below or within the individual specification sections, all costs to perform the complete field testing shall be borne by the Contractor.
2. Satisfactory results of these tests do not in any way relieve the Contractor from conforming with all requirements of the Contract Documents, shop drawings, and project specifications. Installation of the work on the remainder of the building is to be done exactly as in the area checked unless otherwise instructed in writing.
3. No pretesting of prepared area is permitted.
4. Field functional performance testing shall be performed in accordance with referenced methods as specified below.
 - a. ASTM E1186-03 (2009), *Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems*, Section 4.2.1 *Building Depressurization or Depressurization with Infrared Scanning Techniques*
 - b. ASTM E1186-03 (2009), *Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems*, Section 4.2.2 *Smoke Tracer in Conjunction with Building Pressurization or Depressurization*
 - c. ASTM E1186-03 (2009), *Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems*, Section 4.2.6 *Chamber Pressurization or Depressurization in Conjunction with Smoke Tracers*

- d. *ASTM E1186-03 (2009), Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems, Section 4.2.7 Chamber Depressurization in Conjunction with Leak Detection Liquid*
- e. *ASTM E1105-15, Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls, by Uniform or Cyclic Static Air Pressure Difference*
- f. *AAMA 501.1-05, Standard Test Method for Water Penetration of Windows, Curtain Walls and Doors using Dynamic Pressure*
- g. *AAMA 501.2-09, Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls, and Sloped Glazing Systems*
- h. *ASTM E783-02 (2010), Standard Test Method for Field Measurement of Air Leakage Through Exterior Windows and Doors*
- i. *ASTM D4541-09e1, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers*
- j. *ASTM C1521-13, Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints*
- k. *ASTM C1153-10(2015), Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging*
- l. *ASTM D5957-98(2013), Standard Guide for Flood Testing Horizontal Waterproofing Installations*
- m. *ABAA, Standard Method for Building Enclosure Airtightness Compliance Testing*

5. Field Functional Performance Testing Procedure:

- a. Self-Adhered Air (Vapor) Barrier and Waterproofing Membrane Testing:
 - i. ASTM D4541: Pull-off adhesion testing
 - a. Testing Extent: Perform a minimum of 12 adhesion tests on separate facades, separate air/water barrier materials as applicable.
 - ii. ASTM E1186, 4.2.7: Chamber depressurization in conjunction with leak detection liquid
 - b. Testing Extent: Perform a minimum of 20 air leakage tests on the opaque wall. Conduct testing on separate wall assemblies as applicable.
 - iii. ASTM D5957: Flood testing of all horizontal surfaces above occupied space and/or as directed by owner based on the testing contract:
 - a. Minimum of two inches of water at all conditions.
 - b. All identified breaches shall be repaired.
- b. Sealant Testing:
 - i. ASTM C1521, Method A Tail Procedure
 - ii. Perform two tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.
 - iii. Perform one test for every 1000 feet of joint length thereafter or one test per each floor per elevation.
 - iv. Testing may be conducted by the sealant MFG or as contracted by the owner.
- c. Fenestration and Air Barrier Assemblies Testing:

- i. ASTM E783/E1105; static pressure air and water testing; minimum of five (5) areas of the building, including each fenestration system. Testing shall be performed at 10%, 50%, and 90% completion for a total of 15 tests.
 - ii. ALTERNATE to the above: AAMA 501.1; dynamic pressure water testing at each location. (Note: This testing is limited to the first three floors due to equipment reach.) BECxP will determine where AAMA 501.1 can be performed in lieu of ASTM E1105.
 - iii. AAMA 501.2; nozzle spray testing; test 500 linear feet of building enclosure system interfaces. Testing shall be performed at 10%, 50%, and 90% completion for a total of 1500 linear feet.
- d. Roofing Testing:
- i. ASTM D5957; Flood testing of all roof surfaces above occupied space.
 - a. Minimum of two inches of water at all conditions as contracted by the owner.
 - b. All identified breaches shall be repaired.
 - ii. ASTM C1153, Non-destructive testing; Infrared Thermography
 - a. Do not perform infrared thermography until rain of sufficient intensity to cause leakage, but after all substantial completion of all roof level construction.
 - b. Perform infrared thermography at all roof areas.
 - iii. Test 10% of drains for proper flow and drainage
- e. ABAA, Standard Method for Building Enclosure Airtightness Compliance Testing:
- i. Testing shall be completed immediately after the building enclosure air barrier system is complete. All penetrations through the air barrier system must be sealed.
 - ii. The building enclosure will be tested excluding HVAC related openings (*reference Section 10.12, Table 1*).
 - iii. Testing will be conducted utilizing the Multipoint Regression Method (*reference Section 11*).
 - iv. A diagnostic evaluation will be performed whether or not the building meets performance requirements to identify building enclosure air leakage sites and thermal losses in accordance with following standards. Results shall be included the testing report.
 - a. Infrared Thermography ASTM E1186, 4.2.1 / ISO 6781.
 - b. There shall be a minimum inside to outside temperature differential of 10°F.
 - c. Interior scanning: Accessible interior surfaces shall be scanned when the building is depressurized to a minimum pressure differential 0.42 psf (20 Pa).
 - d. Exterior scanning: Accessible exterior surfaces shall be scanned when the building is pressurized to a minimum pressure differential 0.42 psf (20 Pa).
 - e. Smoke tracers ASTM E1186, 4.2.2: Smoke tracer is waved across the accessible interior and exterior surfaces when the building is pressurized or depressurized to a minimum pressure differential 0.42 psf (20 Pa).

3.5 FUNCTIONAL PERFORMANCE TEST REQUIREMENTS

A. The performance criteria below apply to the mock-up and field testing of exterior enclosure components. The Owner reserves the right to add in additional testing at the Owner's expense.

B. Air and water performance criteria summary table according to each component:

Component	Building Performance Criteria		
	Air	Water	Adhesion Testing
Curtain Wall and Storefront Glazing	ASTM E1186 (4.2.6) – No major air leaks at an air pressure differential of 1.57 psf (75 Pa). A major leak is defined as air and smoke are visible and easily detectable by hand within one inch of the leak location(s).	AAMA 501.1/ASTM E1105 – No uncontrolled water leakage when tested under a pressure difference of 6.24 psf (575 Pa). AAMA 501.2 – No uncontrolled water leakage. AAMA 511, Optional Sill Dam Test- No water leakage	ASTM C 1521 – Perimeter joint sealant must maintain adhesion and achieve 100% cohesive failure.
	ASTM E783 – Maximum air leakage of 0.09 cfm/sq. ft. at an air pressure differential of 1.57 psf (300 Pa).		
Self-Adhered Weather Barrier and Waterproofing Membrane Assemblies	ASTM E1186 (4.2.7) – Pass/fail criteria shall be no bubbles observed in the leak detection liquid at a pressure differential of 1.57 psf (75 Pa).	AAMA 501.1/ASTM E1105 – No uncontrolled water leakage when tested under a pressure difference of 12.00 psf (575 Pa).	ASTM D4541 – Measured air barrier adhesion strength shall be >16 psi
	ASTM E783 – Maximum air leakage of 0.04 cfm/sq. ft. at an air pressure differential of 1.57 psf (75 Pa).	ASTM D5957 – No water leakage when tested for a minimum of 48 hours.	
	ASTM E1186 (4.2.6) – No major air leaks at an air pressure differential of 1.57 psf (75 Pa). A major leak is defined as air and smoke are visible and easily detectable by hand within one inch of the leak location(s).		
Roofing Systems	N/A	ASTM C1153 – Pass/fail criteria shall be no thermal anomalies indicative of water penetration detected through infrared (IR) thermography.	
		ASTM D5957 – No water leakage when tested for a minimum of 24 hours.	
Whole Building	ABAA, Standard Method for Building Enclosure Airtightness Compliance Testing (Multipoint Regression Method) – The mean value of the pressurization and depressurization air leakage flow calculated from the measured data at pressure differential of 1.57 psf (75 Pa) must not exceed 0.25 cfm/ft ² of the building enclosure surface area.		ASTM C1153– Pass/fail criteria shall be no anomalies indicative of water penetration.
	The following diagnostic evaluation standards shall be performed in conjunction with the air leakage testing outlined above:		
	ASTM E1186 (4.2.1) / ISO 6781 – Accessible interior and exterior surfaces are scanned at minimum pressure differential 0.42 psf (20 Pa) and minimum inside to outside temperature differential of 10°F.		
	ASTM E1186 (4.2.2) – Smoke tracer is waved across the accessible interior and exterior surfaces at minimum pressure differential 0.42 psf (20 Pa).		
	AAMA 501.1/ASTM E1105 – No systemic leaks and all isolated leaks resolved within 3 months post occupancy.		

3.6 COMMISSIONING DOCUMENTATION

A. Final Report Details

1. Final commissioning report will include an executive summary, list of participants and roles, brief building description, overview of commissioning and testing scope, and general description of testing and verification methods. Report will contain evaluation regarding:
 - a. Conformance to specifications and design intent
 - b. Material/system installation
 - c. Functional performance
2. All outstanding non-compliance items will be specifically listed.
3. Recommendations for improvement to system and/or operations, future actions, etc. will also be listed.

END OF SECTION

- H. Seal top of through-wall flashings to air barrier with an additional 6-inch-wide, transition strip.
- I. Seal exposed edges of strips at seams, cuts, penetrations, and terminations not concealed by metal counterflashings or ending in reglets with termination mastic.
- J. Repair punctures, voids, and deficient lapped seams in strips and transition strips. Slit and flatten fishmouths and blisters. Patch with transition strips extending 6 inches beyond repaired areas in strip direction.

3.4 PRIMARY AIR-BARRIER MATERIAL INSTALLATION

- A. Apply air-barrier material to form a seal with strips and transition strips and to achieve a continuous air barrier according to air-barrier manufacturer's written instructions and details. Apply air-barrier material within manufacturer's recommended application temperature ranges.
- B. Low-Build Air Barriers: Apply continuous unbroken air-barrier material to substrates according to the following thickness. Apply an increased thickness of air-barrier material in full contact around protrusions such as masonry ties.
 - 1. Vapor-Permeable, Low-Build Air Barrier: Total dry film thickness as recommended in writing by manufacturer to comply with performance requirements, applied in one or more equal coats. Apply additional material as needed to achieve void- and pinhole-free surface, but do not exceed thickness on which required vapor permeability is based.
- C. Do not cover air barrier until it has been tested and inspected by testing agency.
- D. Correct deficiencies in or remove air barrier that does not comply with requirements; repair substrates and reapply air-barrier components.

3.5 FIELD QUALITY CONTROL

- A. Refer to specification 019115 "Exterior Enclosure Commissioning" for field quality control and functional performance testing requirements.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Inspections: Air-barrier materials, accessories, and installation are subject to inspection for compliance with requirements. Inspections may include the following:
 - 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 - 2. Air-barrier dry film thickness.
 - 3. Continuous structural support of air-barrier system has been provided.
 - 4. Site conditions for application temperature and dryness of substrates have been maintained.
 - 5. Maximum exposure time of materials to UV deterioration has not been exceeded.

6. Surfaces have been primed, if applicable.
 7. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 8. Termination mastic has been applied on cut edges.
 9. Strips and transition strips have been firmly adhered to substrate.
 10. Compatible materials have been used.
 11. Transitions at changes in direction and structural support at gaps have been provided.
 12. Connections between assemblies (air-barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 13. All penetrations have been sealed.
- D. Tests: As determined by testing agency, as outlined in section 019115. ~~from among the following tests:~~
- ~~1. Air Leakage Location Testing: Air barrier assemblies will be tested for evidence of air leakage according to ASTM E1186, chamber pressurization or depressurization with smoke.~~
 - ~~2. Air Leakage Volume Testing: Air barrier assemblies will be tested for air-leakage rate according to ASTM E783 or ASTM E2357.~~
 - ~~3. Adhesion Testing: Air barrier assemblies will be tested for required adhesion to substrate according to ASTM D4541 for each 600 sq. ft. of installed air barrier or part thereof.~~
- E. Air barriers will be considered defective if they do not pass tests and inspections.
1. Apply additional air-barrier material, according to manufacturer's written instructions, where inspection results indicate insufficient thickness.
 2. Remove and replace deficient air-barrier components for retesting as specified above.
- F. Repair damage to air barriers caused by testing; follow manufacturer's written instructions.
- G. Prepare test and inspection reports.

3.6 CLEANING AND PROTECTION

- A. Protect air-barrier system from damage during application and remainder of construction period, according to manufacturer's written instructions.
1. Protect air barrier from exposure to UV light and harmful weather exposure as recommended in writing by manufacturer. If exposed to these conditions for longer than recommended, remove and replace air barrier or install additional, full-thickness, air-barrier application after repairing and preparing the overexposed materials according to air-barrier manufacturer's written instructions.

2. Protect air barrier from contact with incompatible materials and sealants not approved by air-barrier manufacturer.
- B. Clean spills, stains, and soiling from construction that would be exposed in the completed work using cleaning agents and procedures recommended in writing by manufacturer of affected construction.
 - C. Remove masking materials after installation.

END OF SECTION

SECTION 075419

POLYVINYL-CHLORIDE (PVC) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Adhered polyvinyl chloride (PVC) roofing system.
- 2. Roof insulation.
- 3. Cover board.
- 4. Walkways.
- 5. Roof Hatch

- B. Related Requirements:

- 1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
- 2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
- 3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
- 4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
- 5. Section 221423 "Storm Drainage Piping Specialties" for roof drains.

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D1079 and glossary in NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site.

- 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.

- E. Water-Based, Fabric-Backed Membrane Adhesive: Roofing system manufacturer's standard water-based, cold-applied adhesive formulated for compatibility and use with fabric-backed membrane roofing.
- F. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- G. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roofing components to substrate, and acceptable to roofing system manufacturer.
- H. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, preformed inside and outside corner sheet flashings, T-joint covers, lap sealants, termination reglets, and other accessories.

2.4 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by PVC roof membrane manufacturer.
- B. Polyisocyanurate Board Insulation: ASTM C1289, felt or glass-fiber mat facer on both major surfaces.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. GAF.
 - c. Johns Manville; a Berkshire Hathaway company.
 - d. Sarnafil.
 - 2. Compressive Strength: 20 psi.
 - 3. Size: 48 by 48 inches or 48 by 96 inches.
 - 4. Thickness: As indicated on drawings. Insulation shall be in two (2) layers, with joints staggered.
- C. Tapered Insulation: Provide factory-tapered insulation boards.
 - 1. Material: Match roof insulation.
 - 2. Minimum Thickness: 1/4 inch.
 - 3. Slope:
 - a. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

2.5 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.

- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
- D. Cover Board: ASTM C1177/C1177M, glass-mat, water-resistant gypsum board or ASTM C1278/C1278M fiber-reinforced gypsum board.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Gypsum LLC.
 - c. National Gypsum Company.
 - 2. Thickness: 1/2 inch.
 - 3. Surface Finish: Factory primed.

2.6 BALLAST

- A. Roof Pavers: Heavyweight, hydraulically pressed concrete units, with top edges beveled 3/16 inch, factory cast for use as roof pavers; absorption not greater than 5 percent, ASTM C140/C140M; no breakage and maximum 1 percent mass loss when tested for freeze-thaw resistance, ASTM C67; and as follows:
 - 1. Size: 24 by 24 inches nominal. Manufacture pavers to dimensional tolerances of plus or minus 1/16 inch in length, height, and thickness.
 - 2. Weight: 15-22 lb/sq. ft.
 - 3. Compressive Strength: 6500 psi, minimum.
 - 4. Colors and Textures: As selected by Architect from manufacturer's full range.
 - 5. Pedestals: manufacturer's standard adjustable pedestal and shims to accommodate various height adjustments of 1/2 inch to 2 inches. Minimum base diameter shall be 6" and minimum top diameter shall be 5 inch.

2.7 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway pads or rolls, approximately 3/16 inch thick and acceptable to roofing system manufacturer.
 - 1. Size: Approximately 36 by 60 inches.
 - 2. Color: Contrasting with roof membrane.

2.8 MECHANICAL ROOF HATCH ASSEMBLY

- A. Furnish and install, where indicated on plans, a new metal mechanical roof hatch assembly. The roof hatch shall be single leaf. The roof hatch shall be pre-assembled from the manufacturer. The hatch assembly shall have integrated safety railing and a telescoping fall-protection bar.
1. Size: 3'-0" wide x 3'-0" long (hinge side as indicated on plan).
 2. Type: E-90, stainless steel.
 3. Manufacturer: The Bilco Company, of New Haven, Connecticut, or approved equal.
- B. Performance Characteristics:
1. Cover shall be reinforced to support a minimum live load of 20psf, with a maximum deflection of 1/150th of the span.
 2. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing.
 3. Operation of the cover shall not be affected by temperature.
 4. The entire hatch assembly shall be weathertight, with fully welded corner joints on the curb and cover.
- C. Cover: The cover shall be brake-formed, hollow metal design, fabricated of 14-gauge Type 304 stainless steel, with a 3" beaded, overlapping flange, fully welded at the corners, and internally reinforced for a 40psf live load.
- D. Gasket: The cover shall have a heavy extruded EPDM rubber gasket that is bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- E. Cover Insulation: The cover insulation shall utilize fiberglass of 1" thickness, fully covered and protected by a metal liner of 22-gauge Type 304 stainless steel.
- F. Curb: The curb shall be 12" in height and fabricated of 14-gauge Type 304 stainless steel. The curb shall be formed with a 3½" flange with 7/16" holes provided for securing to wood nailers. The curb shall be equipped with an integral metal cap flashing of the same gauge and material as the curb, fully welded at the corners, that features stamped tabs, 6" O. C., to be bent inward to hold single-ply flashing membrane securely in place.
- G. Curb Insulation: Curb insulation shall be rigid, high-density fiberboard of 1" thickness, on the exterior surfaces of the curb.
- H. Lifting Mechanisms: Manufacturer shall provide compression spring operators enclosed in telescopic tubes to provide, smooth, easy, and controlled cover operation throughout the entire arc of opening and closing. The upper tube (outer tube) shall extend down over the inner tube, so as to prevent accumulation of moisture, grit, and debris inside the lower tube assembly. The lower tube shall interlock with a flanged support shoe welded to the curb assembly.

- I. Safety Railing: Pre-manufactured fixed railing system, to be mechanically attached to the roof hatch/curb assembly, as manufactured by the hatch/curb assembly manufacturer. Safety railing shall meet or exceed all requirements under OSHA 29 CFR 1910.23.
- J. Safety Post: Pre-manufactured telescoping steel safety post, to be mechanically attached to the existing steel roof access ladder (inside the hatch opening), as manufactured by the roof hatch/curb assembly manufacturer.
- K. Hardware:
 - 1. Heavy pintle hinges shall be provided.
 - 2. The cover shall be equipped with a spring latch with interior and exterior turn handles.
 - 3. The roof hatch assembly shall be equipped with interior and exterior padlock hasps.
 - 4. The latch strike shall be a stamped component, that is bolted to the curb assembly.
 - 5. The cover shall automatically lock in the open position with a rigid hold-open arm, equipped with a 1" diameter red vinyl grip handle, to permit easy release for closing.
 - 6. The compression spring tubes and all other hardware shall be fabricated of Type 316 stainless steel.
 - 7. The cover hardware shall be bolted into heavy-gauge channel reinforcing, welded to the underside of the cover and concealed within the insulation space.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system 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. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
 - 1. Submit test result within 24 hours of performing tests.
 - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

3.3 INSTALLATION OF ROOFING, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions, SPRI's Directory of Roof Assemblies listed roof assembly requirements, and FM Global Property Loss Prevention Data Sheet 1-29.
- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at end of workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.
- C. Install roof membrane and auxiliary materials to tie in to existing roofing to maintain weathertightness of transition.

3.4 INSTALLATION OF INSULATION

- A. Coordinate installing roofing system components, so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
 - 1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows and with long joints continuous at right angle to flutes of decking.
 - a. Locate end joints over crests of decking.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.

- e. Fill gaps exceeding 1/4 inch with insulation.
 - f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - g. Loosely lay base layer of insulation units over substrate.
 - h. Mechanically attach base layer of insulation using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
 - 1) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - f. Trim insulation so that water flow is unrestricted.
 - g. Fill gaps exceeding 1/4 inch with insulation.
 - h. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - i. Loosely lay each layer of insulation units over substrate.
 - j. Adhere each layer of insulation to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - ~~1) Set each layer of insulation in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.~~
 - 2) Set each layer of insulation in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - 3) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.5 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.

1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.
3. Cut and fit cover board tight to nailers, projections, and penetrations.
4. Adhere cover board to substrate using adhesive according to SPRI's Directory of Roof Assemblies listed roof assembly requirements for specified Wind Uplift Load Capacity and FM Global Property Loss Prevention Data Sheet 1-29, as follows:
 - a. ~~Set cover board in a solid mopping of hot roofing asphalt, applied within plus or minus 25 deg F of equiviscous temperature.~~
 - b. Set cover board in ribbons of bead-applied insulation adhesive, firmly pressing and maintaining insulation in place.
 - c. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.6 INSTALLATION OF ADHERED ROOF MEMBRANE

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- D. Accurately align roof membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeter of roofing.
- G. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- H. Seams: Clean seam areas, overlap roofing, and hot-air weld side and end laps of roof membrane and sheet flashings to ensure a watertight seam installation.
 1. Test lap edges with probe to verify seam weld continuity. Apply lap sealant to seal cut edges of roof membrane and sheet flashings.
 2. Verify field strength of seams a minimum of twice daily, and repair seam sample areas.

3. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.

I. Spread sealant bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.7 INSTALLATION OF BASE FLASHING

A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.

B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.

C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.

D. Clean seam areas, overlap, and firmly roll sheet flashings into the adhesive. Hot-air weld side and end laps to ensure a watertight seam installation.

E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.8 INSTALLATION OF WALKWAYS

A. Flexible Walkways: Install walkway products according to manufacturer's written instructions.

1. Install flexible walkways at the following locations:

a. Perimeter of each rooftop unit.

b. Between each rooftop unit location, creating a continuous path connecting rooftop unit locations.

c. Between each roof hatch and each rooftop unit location or path connecting rooftop unit locations.

d. Top and bottom of each roof access ladder.

e. Between each roof access ladder and each rooftop unit location or path connecting rooftop unit locations.

f. Locations indicated on Drawings.

g. As required by roof membrane manufacturer's warranty requirements.

2. Provide 6-inch clearance between adjoining pads.

3. Heat weld to substrate or adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions.

3.9 FIELD QUALITY CONTROL

A. Refer to specification 019115 "Exterior Enclosure Commissioning" for field quality control and functional performance testing requirements.

- B. Testing Agency: Engage a qualified testing agency to inspect substrate conditions, surface preparation, roof membrane application, sheet flashings, protection, and drainage components, and to furnish reports to Architect.
- ~~C. Perform the following tests:~~
- ~~1. Flood Testing: Flood test each roofing area for leaks, according to recommendations in ASTM D5957, after completing roofing and flashing but before overlying construction is placed. Install temporary containment assemblies, plug or dam drains, and flood with potable water.~~
 - ~~a. Perform tests before overlying construction is placed.~~
 - ~~b. Flood to an average depth of 2 1/2 inches with a minimum depth of 1 inch and not exceeding a depth of 4 inches. Maintain 2 inches of clearance from top of base flashing.~~
 - ~~c. Flood each area for 24 hours.~~
 - ~~d. After flood testing, repair leaks, repeat flood tests, and make further repairs until roofing and flashing installations are watertight.~~
 - ~~1) Cost of retesting is Contractor's responsibility.~~
 - ~~e. Testing agency shall prepare survey report indicating locations of initial leaks, if any, and final survey report.~~
 - ~~2. Testing agency shall prepare survey report indicating locations of initial discontinuities, if any.~~
- D. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion, in presence of Architect, and to prepare inspection report.
- E. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- F. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.10 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of kind indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of sealant backings.
 - 2. Do not stretch, twist, puncture, or tear sealant backings.
 - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.
 - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified in subparagraphs below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
 - 1. Remove excess sealant from surfaces adjacent to joints.
 - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
 - 3. Provide concave joint profile per Figure 8A in ASTM C1193 unless otherwise indicated.

3.4 FIELD QUALITY CONTROL

- A. Refer to specification 019115 "Exterior Enclosure Commissioning" for field quality control and functional performance testing requirements.
- ~~B. Field Adhesion Testing: Field test joint sealant adhesion to joint substrates as follows:
 - 1. ~~Extent of Testing: Test completed and cured sealant joints as follows:
 - a. ~~Perform 10 tests for the first 1000 feet of joint length for each kind of sealant and joint substrate.~~
 - b. ~~Perform one test for each 1000 feet of joint length thereafter or one test per each floor per elevation.~~~~~~

- ~~2. Test Method: Test joint sealants according to Method A, Field Applied Sealant Joint Hand Pull Tab, in Appendix X1 in ASTM C1193 or Method A, Tail Procedure, in ASTM C1521.~~
 - ~~a. For joints with dissimilar substrates, verify adhesion to each substrate separately; extend cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.~~
 - ~~3. Inspect tested joints and report on the following:~~
 - ~~a. Whether sealants filled joint cavities and are free of voids.~~
 - ~~b. Whether sealant dimensions and configurations comply with specified requirements.~~
 - ~~c. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each kind of product and joint substrate. Compare these results to determine if adhesion complies with sealant manufacturer's field adhesion hand pull test criteria.~~
 4. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant material, sealant configuration, and sealant dimensions.
 5. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
- C. Evaluation of Field-Adhesion-Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

- A. Clean off excess sealant or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.6 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out, remove, and repair damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original work.

3.7 JOINT-SEALANT SCHEDULE

A. Joint-Sealant Application: Exterior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

- a. Construction joints in cast-in-place concrete.
- b. Control and expansion joints in unit masonry.
- c. Joints between metal panels.
- d. Joints between different materials listed above.
- e. Perimeter joints between materials listed above and frames of doors, windows, and louvers.
- f. Other joints as indicated on Drawings.

2. Joint Sealant: Silicone, nonstaining, S, NS, 50, NT.

3. Joint-Sealant Color: As selected by Owner from manufacturer's full range of colors.

B. Joint-Sealant Application: Interior joints in horizontal traffic surfaces.

1. Joint Locations:

- a. Isolation joints in cast-in-place concrete slabs.
- b. Control and expansion joints in tile flooring.
- c. Other joints as indicated on Drawings.

2. Joint Sealant: Urethane, S, P, 25, T, NT.

3. Joint-Sealant Color: As selected by Owner from manufacturer's full range of colors.

C. Joint-Sealant Application: Interior joints in vertical surfaces and horizontal nontraffic surfaces not subject to significant movement.

1. Joint Locations:

- a. Control joints on exposed interior surfaces of exterior walls.
- b. Perimeter joints between interior wall surfaces and frames of interior doors, windows and elevator entrances.
- c. Other joints as indicated on Drawings.

2. Joint Sealant: Acrylic latex.

3. Joint-Sealant Color: As selected by Architect from manufacturer's full range of colors.

D. Joint-Sealant Application: Mildew-resistant interior joints in vertical surfaces and horizontal nontraffic surfaces.

1. Joint Locations:

- a. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - b. Tile control and expansion joints where indicated.
 - c. Other joints as indicated on Drawings.
2. Joint Sealant: Silicone, mildew resistant, acid curing, S, NS, 25, NT.
 3. Joint-Sealant Color: As selected by Owner from manufacturer's full range of colors.
- E. Joint-Sealant Application: Concealed mastics.
1. Joint Locations:
 - a. Aluminum thresholds.
 - b. Sill plates.
 - c. Other joints as indicated on Drawings.
 2. Joint Sealant: Butyl-rubber based.
 3. Joint-Sealant Color: As selected by Owner from manufacturer's full range of colors.

END OF SECTION

- C. **Sill Pan Flashing: Aluminum sill pan with minimum 1-1/2 inch rear leg, with weathertight corners and joints.**
- D. Concealed Flashing: Dead-soft, 0.018-inch-thick stainless steel, complying with ASTM A240/A240M, of type recommended by manufacturer.
- E. Bituminous Paint: Cold-applied asphalt-mastic paint containing no asbestos, formulated for 30-mil thickness per coat.
- F. Rigid PVC Filler.

2.9 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior.
 - 6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- D. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
- E. Storefront Framing: Fabricate components for assembly using shear-block system.
- F. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At interior and exterior doors, provide compression weather stripping at fixed stops.
- G. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At exterior doors, provide weather sweeps applied to door bottoms.
- H. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.

- I. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.10 ALUMINUM FINISHES

- A. High-Performance Organic Finish: Three-coat fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

- 1. Color and Gloss: As selected by Owner from manufacturer's full range.

2.11 SOURCE QUALITY CONTROL

- A. Structural Sealant: Perform quality-control procedures complying with ASTM C1401 recommendations, including, but not limited to, assembly material qualification procedures, sealant testing, and assembly fabrication reviews and checks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions, to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:

1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Set continuous sill members and flashing in full sealant bed, as specified in Section 079200 "Joint Sealants," to produce weathertight installation.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- F. Install glazing as specified in Section 088000 "Glazing."
- G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.
- H. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.
1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
 2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2-inch-wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.5 FIELD QUALITY CONTROL

- A. Refer to specification 019115 "Exterior Enclosure Commissioning" for field quality control and functional performance testing requirements.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. ~~Field Quality Control Testing: Perform the following test on representative areas of aluminum framed entrances and storefronts.~~
 - 1. ~~Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.~~
 - a. ~~Perform a minimum of two tests in areas as directed by the Engineer.~~
 - 2. ~~Air Infiltration: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static air pressure differential of 1.57 lbf/sq. ft..~~
 - a. ~~Perform a minimum of two tests in areas as directed by the Engineer.~~
 - 3. ~~Water Penetration: ASTM E1105 at a minimum uniform and cyclic static air pressure differential of 0.67 times the static air pressure differential specified for laboratory testing in "Performance Requirements" Article, but not less than 6.24 lbf/sq. ft., and shall not evidence water penetration.~~
- D. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 MAINTENANCE SERVICE

- A. Entrance Door Hardware:
 - 1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.
 - 2. Initial Maintenance Service: Beginning at Substantial Completion, provide six months' full maintenance by skilled employees of entrance door hardware Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper entrance door hardware operation at rated speed and capacity. Use parts and supplies that are the same as those used in the manufacture and installation of original equipment.

END OF SECTION

- a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.6 FIELD QUALITY CONTROL

- A. Refer to specification 019115 "Exterior Enclosure Commissioning" for field quality control and functional performance testing requirements.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- ~~C. Test Area: Perform tests on representative areas of glazed aluminum curtain walls.~~
- ~~D. Field Quality Control Testing: Perform the following test on representative areas of glazed aluminum curtain walls.~~
- ~~1. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested in accordance with AAMA 501.2 and shall not evidence water penetration.~~
 - a. ~~Perform a minimum of two tests in areas as directed by Engineer.~~
 - ~~2. Air Leakage: ASTM E783 at 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article but not more than 0.09 cfm/sq. ft. at a static air pressure differential of 1.57 lbf/sq. ft..~~
 - a. ~~Perform a minimum of two tests in areas as directed by Engineer.~~
- E. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports.

END OF SECTION

- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Comply with manufacturer's written instructions.
 - 1. Do not install damaged components.
 - 2. Fit joints between aluminum components to produce hairline joints free of burrs and distortion.
 - 3. Rigidly secure nonmovement joints.
 - 4. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 5. Seal joints watertight unless otherwise indicated.
- B. Metal Protection: Where aluminum will contact dissimilar materials, protect against galvanic action by painting contact surfaces with protective coating or by installing nonconductive spacers as recommended in writing by manufacturer for this purpose.
- C. Install continuous aluminum sill closure with weatherproof expansion joints and locked and sealed or welded corners. Locate weep holes at rafters.
- D. Install components to drain water passing joints, and moisture migrating within skylight to exterior.
- E. Install components plumb and true in alignment with established lines and elevations.
- F. Glazing: Install glazing as specified in Section 088000 "Glazing".
- G. Erection Tolerances: Install metal-framed skylights to comply with the following maximum tolerances:
 - 1. Alignment: Limit offset from true alignment to 1/32 inch where surfaces abut in line, edge to edge, at corners, or where a reveal or protruding element separates aligned surfaces by less than 3 inches; otherwise, limit offset to 1/8 inch.
 - 2. Location and Plane: Limit variation from true location and plane to 1/8 inch in 12 feet but no greater than 1/2 inch over total length.

3.3 FIELD QUALITY CONTROL

- A. Refer to specification 019115 "Exterior Enclosure Commissioning" for field quality control and functional performance testing requirements.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
 - 1. ~~Water Spray Test: Before installation of interior finishes has begun, skylights shall be tested according to AAMA 501.2 and shall not evidence water penetration.~~

- C. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
- D. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- E. Prepare test and inspection reports.

3.4 CLEANING AND PROTECTION

- A. Clean exposed surfaces immediately after installing skylights. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Protect skylights from contact with contaminating substances resulting from construction operations. If contaminating substances do contact skylight surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION

SECTION 101423.16

ROOM-IDENTIFICATION PANEL SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes room-identification signs that are directly attached to the building.

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.4 COORDINATION

- A. Furnish templates for placement of sign-anchorage devices embedded in permanent construction by other installers.
- B. Furnish templates for placement of electrical service embedded in permanent construction by other installers.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For room-identification signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, typestyles, graphic elements, including raised characters and Braille, and layout for each sign..
- C. Samples for Verification: For each type of sign assembly showing all components and with the required finish(es), in manufacturer's standard size unless otherwise indicated and as follows:
 - 1. Room-Identification Signs: Full-size Sample.

2. Full-size Samples, if approved, will be returned to Contractor for use in Project.

D. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.6 INFORMATIONAL SUBMITTALS

A. Sample Warranty: For special warranty.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For signs to include in maintenance manuals.

1.8 FIELD CONDITIONS

A. Field Measurements: Verify locations of anchorage devices embedded in permanent construction by other installers by field measurements before fabrication, and indicate measurements on Shop Drawings.

1.9 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Deterioration of finishes beyond normal weathering.
- b. Deterioration of embedded graphic image.
- c. Separation or delamination of sheet materials and components.

2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 ROOM-IDENTIFICATION SIGNS

A. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:

1. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated to acrylic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: Manufacturer's standard for size of sign but not less than 0.125 inch.
 - b. Color(s): As selected by Architect from manufacturer's full range.
2. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: As indicated on Drawings.
 - b. Corner Condition in Elevation: As indicated on Drawings.
3. Mounting: Manufacturer's standard method for substrates indicated.
4. Text and Typeface: Accessible raised characters and Braille, typeface as selected by Architect from manufacturer's full range. Finish raised characters to contrast with background color, and finish Braille to match background color.

2.3 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- B. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
 1. Use concealed fasteners and anchors unless indicated to be exposed.
 2. For exterior exposure, furnish stainless-steel devices unless otherwise indicated.
 3. Sign Mounting Fasteners:
 - a. Concealed Studs: Concealed (blind), threaded studs welded or brazed to back of sign material or screwed into back of sign assembly unless otherwise indicated.
 - b. Through Fasteners: Exposed metal fasteners matching sign finish, with type of head indicated, and installed in predrilled holes.
- B. Adhesive: As recommended by sign manufacturer.
- C. Two-Face Tape: Manufacturer's standard high-bond, foam-core tape, 0.045 inch thick, with adhesive on both sides.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 - 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 - 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 - 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.
 - 4. Provide rabbets, lugs, and tabs necessary to assemble components and to attach to existing work. Drill and tap for required fasteners. Use concealed fasteners where possible; use exposed fasteners that match sign finish.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Accessibility: Install signs in locations on walls according to the accessibility standard.
- C. Mounting Methods:
 - 1. Concealed Studs: Using a template, drill holes in substrate aligning with studs on back of sign. Remove loose debris from hole and substrate surface.

- a. **Masonry Substrates:** Fill holes with adhesive. Leave recess space in hole for displaced adhesive. Place sign in position and push until flush to surface, embedding studs in holes. Temporarily support sign in position until adhesive fully sets.
 - b. **Thin or Hollow Surfaces:** Place sign in position and flush to surface, install washers and nuts on studs projecting through opposite side of surface, and tighten.
2. **Through Fasteners:** Drill holes in substrate using predrilled holes in sign as template. Countersink holes in sign if required. Place sign in position and flush to surface. Install through fasteners and tighten.
 3. **Adhesive:** Clean bond-breaking materials from substrate surface and remove loose debris. Apply linear beads or spots of adhesive symmetrically to back of sign and of suitable quantity to support weight of sign after cure without slippage. Keep adhesive away from edges to prevent adhesive extrusion as sign is applied and to prevent visibility of cured adhesive at sign edges. Place sign in position, and push to engage adhesive. Temporarily support sign in position until adhesive fully sets.
 4. **Two-Face Tape:** Clean bond-breaking materials from substrate surface and remove loose debris. Apply tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage. Keep strips away from edges to prevent visibility at sign edges. Place sign in position, and push to engage tape adhesive.

3.2 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

3.3 ROOM IDENTIFICATION PANEL SIGNAGE SCHEDULE

- A. Provide signs on the entry side of the following rooms:
 1. Elevator Machine Room
 2. Janitor Closets
 3. Reception/Security
 4. Mail/Storage
 5. Training Room
 6. Conference Rooms/ Workrooms
 7. Women's Toilet and Shower Rooms
 8. Men's Toilet and Shower Rooms
 9. Server Rooms
 10. Personal Rooms

11. Mechanical Room
12. Electrical Room
13. Sprinkler Room
14. Stairs
15. Open Office Areas
16. Storage Rooms
17. Lunch/Vending Room

B. Coordinate room names and numbers (if applicable) with owner.

END OF SECTION

- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Furnish well casing and coordinate delivery with related excavation work.
- C. Coordinate locations and dimensions of other work specified in other Sections that relates to hydraulic elevators, including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: 1 year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following manufacturer:
1. Lochnivar.
 2. Weil-McLain
 3. HTP
 4. Thermal Solutions – Apex Series

2.2 DESIGN

- A. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base, including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water-heating service only.
- B. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
- C. Pressure Vessel: Carbon steel with welded heads and tube connections.
- D. Burner: Natural gas, forced draft.
- E. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
1. Motors: Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Motor Sizes: Minimum size as indicated; if not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- F. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- G. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- H. Casing:
1. Jacket: Sheet metal, with snap-in or interlocking closures.
 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 3. Finish: Baked-enamel or powder-coat protective finish.
 4. Insulation: Minimum 2-inchthick, polyurethane-foam insulation surrounding the heat exchanger.

2.12 WIRE AND WIRING SYSTEM

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. West Penn Wire/COT; a division of Cable Design Technologies
 - 2. Comtran Corporation
 - 3. Helix/HiTemp Cables, Inc, a Draka USA Company
 - 4. Rockbestos-Suprenant Cable Corporation, a Mamlon Group Company
- B. Non-power-limited circuits: Solid-copper conductors with 600-V rated, 75 deg. C, color coded insulation
 - 1. Low voltage circuits: No. 16 AWG minimum
 - 2. Line-voltage circuits: No. 12 AWG, minimum
- C. Power-limited circuits: NFPA 70, Types FPL, FPLR, or FPLP as recommended by manufacturer
- D. Wiring System: Class A in accordance with NFPA 72.

2.13 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically ~~capture two telephone line(s) and~~ dial a preset number for a remote central station through a cellular connection. When contact is made with central station(s), signals shall be transmitted. ~~If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If~~ cellular service is lost ~~on both telephone lines~~, transmitter shall initiate the local trouble signal.
- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that cellular service ~~both telephone lines~~ are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.
- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.