



Loudoun County, Virginia

Division of Procurement
1 Harrison St, SE 4th Floor
Leesburg, Virginia 20175

September 14, 2020

NOTICE TO BIDDERS

ADDENDUM NO. 4

RFQ 216783

The following changes and/or additions shall be made to the original Invitation for Bid No. RFQ 216783: Construction of the Sterling Park Safety Center. Please acknowledge receipt of this addendum by signing and returning with your bid.

The purpose of this addendum is to modify the contract documents.

1. Attachment 1 contains new and revised specifications for the following:
 - a. 019113 – Commissioning Requirements is a complete replacement of the previously issued specification.
 - b. 019118 – Building Envelope Commissioning is a new specification added.

Prepared By: s/Samira Mkaimel, CPPB
Contracting Officer

Date: September 14, 2020

Acknowledged By: _____

Date: _____

ATTACHMENTS:

Attachment 1 – Commissioning Specifications

RFQ 216783 - ATTACHMENT 1

Project Specifications: Sterling Park Safety Center
Loudoun County, Virginia
Architect's Project No: 545003

SECTION 001100 - PROJECT MANUAL TABLE OF CONTENTS (*AD 03) (*AD 04)

DIVISION 00 – BIDDING AND CONTRACTUAL REQUIREMENTS

Bidding and Contractual Requirements for this project shall be issued by Loudoun County under separate cover. All provisions of these Bidding and Contractual Requirements shall apply to the Construction Documents for this project.

DIVISION 1 – GENERAL REQUIREMENTS (Owner Provided)

011000	Summary of Work
011100	General Requirements
012413	Value Engineering
012500	Clarifications and Requests for Information
013100	Preconstruction Conference and Preconstruction Submittals
013119	Project Meetings
013200	Construction Progress Documentation
013216	Activities Schedule
013217	Payment Procedures
013300	Submittal Procedures
013620	Indoor Air Quality Management Plan
014100	Coordination, Field Engineering, and Regulatory Requirements
014500	Contractor Quality Control (CQC)
014500	Contractor Quality Control (Form)
014516	Quality Requirements
014520	Testing, Adjusting, and Balancing for HVAC
015200	Temporary Facilities Utilities, and Access
015639	Temporary Tree and Plant Protection
015719	Environmental Protection
015720	Soil Erosion and Sediment Control
017300	Execution
017419	Construction Waste Management
017800	Project Closeout and Closeout Submittals
017823	O&M Data and Operating Instructions
018113	Sustainable Design Requirements
018119	Indoor Air Quality Requirements
018317	Exterior Building Enclosure Air Barrier Requirements
<u>019113</u>	<u>General Commissioning Requirements (*AD 04)</u>
<u>019118</u>	<u>Building Envelope Commissioning (*AD 04)</u>
Appendix A	Geotechnical Report
Appendix B	Hazardous Materials Report

DIVISION 2 – EXISTING CONDITIONS

<u>024116</u>	<u>Structure Demolition (*AD 03)</u>
028000	Hazardous Materials Remediation

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DIVISION 3 – CONCRETE

031119	Insulating Concrete Slab Edge Forming
033000	Cast-In-Place Concrete
033544	Stained and Polished Concrete Floor Finishing
034500	Architectural Precast Concrete

DIVISION 4 – MASONRY

042000	Unit Masonry
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DIVISION 5 – METALS

051200	Structural Steel Framing
052100	Steel Joist Framing
053100	Steel Decking
054000	Cold Formed Steel Framing – Structural (CFSF-S)
054003	Continuous Insulation (CI) Framing System
055000	Metal Fabrications
055100	Metal Stairs
055213	Pipe and Tube Railings
<u>057300</u>	<u>Decorative Metal Railings (*AD 03)</u>
057500	Decorative Formed Metal

DIVISION 6 – WOOD PLASTICS AND COMPOSITES

061000	Rough Carpentry
061600	Sheathing
064023	Interior Architectural Woodwork

DIVISION 7 – THERMAL AND MOISTURE PROTECTION

<u>072100</u>	<u>Thermal Insulation (*AD 03)</u>
072727	Sprayed Polyurethane Foam Air Barrier
<u>074233</u>	<u>High Pressure Laminate (HPL) Wall Panels (*AD 03)</u>
075419	Polyvinyl Chloride (PVC) Roofing
<u>076201</u>	<u>Flashing, Sheet Metal and Roofing Accessories (*AD 03)</u>
078100	Applied Fireproofing
078123	Intumescent Mastic Fireproofing
078413	Penetration Firestopping
078426	Thermal Barriers for Plastics
078446	Fire-Resistive Joint Systems
079200	Joint Sealants

DIVISION 8 – OPENINGS

081113	Steel Doors and Frames
081416	Flush Wood Doors
083113	Access Doors and Frames
<u>083323</u>	<u>Overhead Coiling Doors (*AD 03)</u>
083613	Exterior Four-Fold Apparatus Bay Doors

084000 **Aluminum Entrances, Storefront, and Curtainwall (*AD 03)**

087100	Door Hardware
087113	Automatic Door Operators
088000	Glazing
088050	Glazed Draft Curtain
088300	Mirrors
088713	Solar Control Window Film

089119 **Fixed Louvers (*AD 03)**

DIVISION 9 – FINISHES

092116	Gypsum Board Shaft Wall Assemblies
092216	Cold Formed Steel Framing - Non-Structural (CFSF-NS)
092900	Gypsum Board

093000 **Tiling (*AD 03)**

095113	Acoustical Panel Ceilings
095126	Acoustical Wood Ceilings
096513	Resilient Base and Accessories
096519	Resilient Tile Flooring

096566.13 **Rubber Athletic Flooring (*AD 03)**

096724 **High-Performance Floor Coating System (*AD 03)**

096817	VCTT Flooring
097200	Wall Coverings

098316 **Sprayed Acoustical Ceiling Treatment (*AD 03)**

098413	Acoustical Wall Panels
099100	Painting
099400	Decorative Finishes

DIVISION 10 – SPECIALTIES

101100 **Visual Display Surfaces (*AD 03)**

101200	Display Cases – Semi Recessed
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101400 **Signage (*AD 03)**

102113 **Solid Polymer Toilet Compartments (*AD 03)**

102214	Chain-Link Partitions and Gates
102600	Wall and Door Protection
102800	Toilet and Bath Accessories
104400	Fire Protection Specialties (FEC + FE)

105112 **Metal Lockers (*AD 03)**

105113	Wire Mesh Turnout Gear Lockers
107500	Flagpoles

DIVISION 11 – EQUIPMENT

112326	Commercial Laundry Equipment
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113100 **Residential Appliances (*AD 03)**

114100 **Foodservice Storage Equipment (*AD 03)**

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116623 Gymnasium Equipment

DIVISION 12 – FURNISHINGS

122413 Roller Window Shades

124813 Entrance Floor Mats and Frames

DIVISION 13 – SPECIAL CONSTRUCTION

133133 Framed Fabric Structures

133423 Modular Building (*AD 03)

DIVISION 14 – CONVEYING SYSTEMS

142400 Hydraulic Elevators

149300 Slide Pole System

DIVISION 21 – FIRE SUPPRESSION

210500 Common Work Results for Fire-Suppression

211000 Water-Based Fire-Suppression Systems

DIVISION 22 – PLUMBING

220500 Common Work Results for Plumbing

220513 Common Motor Requirements for Plumbing Equipment

220516 Expansion Fittings and Loops for Plumbing Piping

220517 Sleeves and Sleeve Seals for Plumbing Piping

220519 Meters and Gages for Plumbing Piping

220523 General-Duty Valves for Plumbing Piping

220529 Hangers and Supports for Plumbing Piping and Equipment

220533 Heat Tracing for Plumbing Piping (*ADD-01)

220553 Identification for Plumbing Piping and Equipment

220700 Plumbing Insulation

221113 Facility Natural Gas Piping

221116 Domestic Water Piping

221119 Domestic Water Piping Specialties

221123 Packaged Booster Pumps

221125 Circulating Pumps

221316 Sanitary Waste and Vent Piping

221319 Sanitary Waste Piping Specialties

221413 Facility Storm Drainage Piping

221423 Storm Drainage Piping Specialties

221429 Sump Pumps

221513 General-Service Compressed-Air Piping

221519 General-Service Packaged Air Compressors and Receivers

223300 Electric Water Heaters

223400 Fuel-fired Domestic Water Heaters

224000 Plumbing Fixtures (*AD 03)

DIVISION 23 – MECHANICAL

230500	Common Work Results for HVAC
230513	Motors for HVAC Equipment
230514	Variable Speed Drives
230517	Sleeves and Sleeve Seals for HVAC Piping
230519	Meters and Gages for HVAC Piping
230523	General-Duty Valves for HVAC Piping
230529	Hangers and Supports for HVAC Piping and Equipment
230548	Vibration and Seismic Control for HVAC
230553	Identification for HVAC Piping and Equipment
230700	HVAC Insulation
<u>230900</u>	<u>Building Automation System (*AD 03)</u>
<u>230993</u>	<u>Sequences of Control (*AD 03)</u>
232113	Hydronic Piping
232123	Hydronic Pumps
232300	Refrigerant Piping
232500	HVAC Water Treatment
233113	Metal Ducts
233300	Air Duct Accessories
233423	HVAC Power Ventilators
233516	Engine Exhaust Systems
233600	Air Terminal Units
233713	Diffusers, Registers, and Grilles
233813	Commercial-Kitchen Hoods
234100	Particulate Air Filtration
235100	Breechings, Chimneys, and Stacks
235216	Condensing Boilers
<u>237223</u>	<u>Packaged, Outdoor, Heat Wheel Energy Recovery Units (*AD 03)</u>
<u>237413</u>	<u>Packaged Outdoor Central Station Air Handling Units (*AD 03)</u>
237433	Direct-Fired Makeup Air Units
<u>237500</u>	<u>Equipment Screens (*AD 03)</u>
238126	Split-System Air-Conditioners
238211	Radiant Heating Panels
238239	Unit Heaters
238313	Radiant-Heating Snow Melt System
238316	Radiant Heating System

DIVISION 25 – INTEGRATED AUTOMATION (not used)

DIVISION 26 – ELECTRICAL

260519	Low-Voltage Electrical Power Conductors and Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
260533	Raceway and Boxes for Electrical Systems

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260543	Underground Ducts and Raceways for Electrical Systems
260544	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
260553	Identification for Electrical Systems
260572	Overcurrent Protective Device Short-Circuit Study
260573	Overcurrent Protective Device Coordination Study
260574	Overcurrent Protective Device ARC-Flash Study
260923	Lighting Control Devices
262416	Panelboards
262726	Wiring Devices
<u>263213</u>	<u>Engine Generators (*AD 03)</u>
<u>263600</u>	<u>Transfer Switches (*AD 03)</u>
<u>264113</u>	<u>Lightning Protection for Structures (*AD 03)</u>
264313	Surge Protection for Low-Voltage Electrical Power Circuits
265119	LED Interior Lighting
265619	LED Exterior Lighting

DIVISION 27 – COMMUNICATIONS

270500	Common Work Results for Communications
271100	Communications Equipment Room Fittings
271300	Communications Backbone Cabling
271500	Communications Horizontal Cabling
274133	Master Antenna Television System
276410	RF BDA-Based Signal Booster System

DIVISIONS 28 – ELECTRONIC SAFETY AND SECURITY

280500	Common Work Results for Electronic Security
280512	Horizontal Cabling System for Electronic Security
280513	Conductors and Cables for Electronic Security
280526	Grounding and Bonding for Electronic Security
281116	Cabinets and Enclosures for Electronic Security
281300	Access Control System for Electronic Security
281353	Video Intercom System
282300	Electronic Surveillance (CCTV)
283111	Digital, Addressable Fire-Alarm System

DIVISION 31 – EARTHWORK

311000	Site Clearing
<u>312000</u>	<u>Earth Moving (*AD 03)</u>
<u>312300</u>	<u>Excavation and Fill (*AD 03)</u>
312500	Erosion Control

DIVISION 32 – EXTERIOR IMPROVEMENTS

320000	General Sitework Requirements
321123	Aggregates Base Courses
321200	Flexible Paving

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321313	Site Concrete
<u>321700</u>	<u>Pavement Markings, Signs and Specialties (*AD 03)</u>
323113	Exterior Fences and Gates
<u>329200</u>	<u>Lawns and Grasses (*AD 03)</u>
<u>329300</u>	<u>Exterior Plants (*AD 03)</u>
<u>329460</u>	<u>Trellis Plant Screen System (*AD 03)</u>

DIVISION 33 – UTILITIES

331000	Exterior Water System
333000	Sanitary Sewerage
334100	Storm Drainage

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SECTION 019113 - GENERAL COMMISSIONING REQUIREMENTS (ADDENDUM NO. 4)

PART 1 – GENERAL

1.1 DESCRIPTION

- A. Commissioning is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objectives and criteria. The commissioning process includes specific tasks to be conducted during construction to verify that construction is performed in accordance with contract requirements, equipment installations provide adequate service access, systems perform in accordance with design intent, and training meets Loudoun County's requirements.
- B. The commissioning process does not take away from or reduce the responsibility of the system designers or installing contractors to provide a finished and fully functioning product.
- C. The commissioning authority is directly contracted by the owner for this project.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the contract, including General and Supplementary Conditions and other Division 1 specification sections, apply to this section.
- B. Commissioning shall be responsive to the installation and performance requirements as specified throughout Divisions 22, 23 and 26.

1.3 COMMISSIONING TEAM

- A. Commissioning Team: The members of the commissioning team consist of:
 - 1. The owner's representative (OR) (Loudoun County Construction Manager)
 - 2. The commissioning authority (CA)
 - 3. The architect and design engineers (AE)
 - 4. The general contractor (GC)
 - 5. The mechanical contractor (MC)
 - 6. The electrical contractor (EC)
 - 7. The testing and balancing contractor (TAB)
 - 8. The controls contractor (ATC)
 - 9. The facility operating and maintenance staff
 - 10. Other installing subcontractors
 - 11. Equipment suppliers and manufacturers representatives
- B. The CA directs and coordinates the project commissioning activities and reports to the Loudoun County PM. All team members work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.

1.4 SCOPE

- A. This section provides the general requirements that apply to the implementation of the Commissioning. Specific components, assemblies, and systems.

B. In general, the following components, assemblies, and systems will be commissioned:

1. HVAC System
2. Building automation controls
3. Lighting and Day lighting Control
4. Domestic Hot Water
5. Power and Distribution Panels
6. Electrical Backup Generator
7. Building Envelope (see spec section 019113)

1.5 COORDINATION

- A. Project Commissioning Team: The members of the project commissioning team will consist of the commissioning authority and any support personnel, the construction manager, Loudoun County's facility staff or designee, the general contractor, subcontractors and/or vendors as required, and the architect/ engineer.
- B. Management: The CA coordinates the commissioning activities through the construction manager. All members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- C. Scheduling: The CA will provide sufficient information to the contractor for required commissioning activities. The contractor will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

1.6 PROCESS

- A. The following is a brief overview of the typical commissioning tasks during and after construction and the general order in which they occur.
1. Commissioning during construction begins with an initial commissioning meeting conducted by the CA where the commissioning process is reviewed with the project commissioning team members.
 2. Additional meetings will be required throughout construction, scheduled by the CA, through the Loudoun County PM or CM, with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve problems.
 3. Equipment documentation is submitted to the CA, through the Loudoun County PM or CM, during normal submittals, including detailed startup procedures.
 4. The pre-functional checklists are to be completed by the contractors throughout the construction installation and during the startup process.
 5. Pre-functional checklists and equipment startup must be completed before systems performance verification. Additionally, testing and balancing and automation system trending must be completed before HVAC systems performance verification can occur.
 6. The contractor ensures that the subcontractors' construction checklists are executed and documented and that startup and initial checkout are performed. The CA verifies that the TAB, construction checklists and startup were completed according to contract requirements.
 7. The CA develops and implements equipment and system performance verification procedures. The performance verification tests are executed by the contractor under the direction of the

CA with participation of the facility staff.

8. Deficiencies discerned during construction, start-up, or performance verification will be documented by the CA. Rectification of deficiencies resides with the contractor or AE.
 9. The CA reviews the O&M documentation for completeness and pertinence; and participates in contractor's instructions and training of Loudoun County's operating and maintenance personnel.
- B. Other than deferred seasonal performance verification of HVAC systems, all equipment/systems commissioning shall be completed before substantial completion.

1.7 RESPONSIBILITIES

- A. The general responsibilities of various parties in the commissioning process are provided herein.
- B. All Parties
1. Follow the commissioning plan.
 2. Attend initial commissioning meeting and additional meetings as necessary.
- C. Owner's Representative (OR) (Loudoun County PM)
1. Facilitate the coordination of the commissioning work by the CA, and, with the GC and CA, ensure that commissioning activities are being scheduled into the master schedule.
 2. Review and approve the final Commissioning Plan.
 3. Attend a commissioning scoping meeting and other commissioning team meetings.
 4. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CA, or may delegate this duty to the AE.
 5. Review and approve the performance test procedures submitted by the CA.
 6. Observe and witness startup and performance testing of selected equipment.
 7. Review commissioning progress and deficiency reports. Coordinate and enforce the resolution of cited non-compliance issues and deficiencies.
 8. Sign-off (final approval) on individual commissioning tests as completed and passing.
 9. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities and contractor's instructions and training.
 10. Assist the CA as necessary in the seasonal or deferred performance verification and deficiency corrections required by the specifications.
 11. Acknowledge completion of commissioning process and accept substantial completion.
- D. Architect/Engineer (AE)
1. Architect: In addition to performing the normal construction contract administration functions, architect shall:
 - a. Attend initial commissioning meeting and selected commissioning team meetings.
 - b. Provide any design narrative documentation requested by the CA.
 - c. Coordinate with OR to assure that the CA is:
 - 1) Provided copies of approved shop drawings as they are returned to the Contractor.

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- 2) Notified of time, date, and place of all regularly scheduled progress meetings, and of any special meetings that may be called regarding commissioned systems.
 - 3) Copied on all correspondence pertinent to the commissioned systems including but not limited to minutes of progress meetings, responses to contractor requests for information, change order documentation.
- d. Coordinate resolution of cited deficiencies.
2. Engineers: In addition to performing the normal construction contract administration functions of submittals review, site visits, O&M manuals and As-Built documents review, engineers shall:
- a. Attend initial commissioning meeting and other selected commissioning team meetings.
 - b. Provide any design narrative and sequences documentation requested by the CA. Assist in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings, or equipment documentation is not sufficient for writing performance verification procedures.
 - c. Participate in the resolution of cited deficiencies.
 - d. Participate in training of Loudoun County's operating and maintenance personnel, including providing systems design intent.
 - e. Witness performance verification of selected equipment and systems
- E. Contractors: General contractor, subcontractors, and vendors shall assign representatives with expertise and authority to act on their behalf and schedule them to participate in and perform commissioning activities including, but not limited to, the following:
1. Facilitate the coordination of commissioning and incorporate commissioning activities into the project schedule.
 2. Provide detailed startup procedures for all commissioned equipment/systems.
 3. Include the cost of commissioning in the total contract price.
 4. Attend initial commissioning meeting and other selected commissioning team meetings.
 5. GC shall execute the commissioning responsibilities according to the contract documents and ensure that all subcontractors and vendors do likewise. Among the requirements:
 - a. The CA is to be notified to witness construction milestones as required.
 - b. Pre-functional checklists are completed by contractors as work progresses.
 - c. Written responses are to be provided to deficiencies/issues resolution logs issued by the CA; responses are to be returned to the CA within 2-weeks of date of issue.
 - d. O&M manuals are to be submitted for review no later than 60 days after the last shop drawing/submittal has been approved.
 6. Provide the training of Loudoun County personnel. Training plan shall be submitted for approval at least four weeks prior to first training session. Approved O&M manuals shall be employed in training.
 7. Provide equipment/systems performance verification under CA direction, including for seasonal or deferred verification. The contractors shall provide all tools or the use of tools to start, check-out and test equipment and systems. Evaluate performance deficiencies and, in collaboration with entity responsible for system and equipment installation, recommend

corrective action.

F. Commissioning Authority (CA)

1. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
2. Coordinate the commissioning work and, with the GC and Loudoun County PM/CM, help integrate commissioning activities into the master schedule.
3. Revise the Construction Phase Commissioning Plan as necessary.
4. Plan and conduct an initial commissioning meeting and other commissioning meetings as required.
5. Request and review additional information required to perform commissioning tasks, including O&M materials, contractor startup and checkout procedures.
6. Review AE approved contractor submittals applicable to systems being commissioned for compliance with commissioning needs.
7. Write and distribute construction pre-functional checklists. Monitor execution of checklists during construction and provide approval when warranted.
8. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Review construction meeting minutes for revisions/substitutions relating to the commissioning process. Assist in resolving discrepancies.
9. Recommend approval of systems startup by reviewing startup reports and by selected site observation.
10. With necessary assistance and review from AE, installing contractors, and vendors; write the performance verification procedures for equipment and systems. Analyze any performance trend logs and monitoring data to verify performance. Direct, coordinate, and/or witness equipment/systems performance verification and recommend approval. Coordinate retesting as necessary until satisfactory performance is achieved
11. Maintain a master Issues Log. Provide the Loudoun County PM with written progress reports and test results with recommended actions.
12. Witness performance testing of select systems over which the CA may not have direct control such as smoke control systems tested by Fire Marshall, tests by manufacturer's personnel, and other Loudoun County contracted tests. Assure that tests documentation is in O&M manuals.
13. Review equipment warranties to ensure that the Loudoun County's responsibilities are clearly defined.
14. Document the contractor's training of the Loudoun County's operating personnel.
15. Review the O&M manuals.
16. Provide a final commissioning report (as described in this section).

PART 2 – PRODUCTS – NOT USED

PART 3 - EXECUTION

3.1 SEQUENCING AND SCHEDULING: Systems commissioning may be construed to be in three parts:

installation verification, training and demonstrations, and performance verification.

- A. Installation verification utilizes Pre-Functional Check Lists, documenting that equipment/systems are installed in accordance with contract documents, are serviceable, and started in accordance contract requirements and/or manufacturers' recommendations.
- B. Contractor's training of and demonstrations for Loudoun County's operating and maintenance personnel occurs after Pre-Functional Checks are complete and all test and inspection reports and operation and maintenance manuals have been submitted and approved. Training and demonstrations usually precede Performance Verification; some training, such as use and operations of the automation system, occurs during and after performance verifications.
- C. Performance verification employs Functional Performance Verification forms and occurs only after all work required in related Sections has been successfully completed. HVAC systems require functional performance verification in distinct heating and cooling seasons; i.e. a minimum of two sessions of performance verification.

3.2 MEETINGS:

- A. Initial Meeting. Within 60 days of the Notice to Proceed, CA shall schedule an initial commissioning meeting. All commissioning parties are required to attend. CA will issue an agenda and chair the meeting. General content of the meeting will be for the CA to provide an overview of the commissioning process for the project, to establish lines of communications.
- B. Post-Submittal Meeting: Within 30 days after the final submittal approval by trade (mechanical, lighting, etc.), the CA will schedule a coordination meeting for the concerned parties. CA will issue an agenda and chair the meeting. General content of the meeting will be for the CA to provide and discuss pre-functional checklists and performance verification forms.
- C. TAB/ATC Meeting: Prior to commencing the testing and balancing of HVAC systems, the CA will schedule a coordination meeting for the concerned parties. CA will issue an agenda and chair the meeting. General content of the meeting will be for the TAB contractor to discuss their plan for performing the testing and balancing, to assure coordination between TAB and ATC contractor, and to assure appropriate deliverables from contractors.
- D. Miscellaneous Meetings. Other meetings may be planned and conducted by the CA as construction progresses to address coordination, deficiency resolution, and planning issues.

3.3 SUBMITTALS

- A. The CA will review the approved submittals related to the commissioned equipment for conformance to the contract documents as it relates to the commissioning process, to the performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance verification procedures and only secondarily to verify compliance with equipment specifications. The CA will notify the Loudoun County PM, PM and/or AE as requested, of items missing or areas that are not in conformance with contract documents.
- B. The CA may request additional submittal documentation to facilitate the commissioning work. These requests may entail manufacturer's printed installation and detailed startup procedures, full sequences of operation, O&M data, performance test procedures, control drawings and details of Loudoun County contracted tests. All documentation requested by the CA shall be included by the subcontractors in the O&M manuals.

3.4 CONSTRUCTION CHECKLISTS AND START-UP

- A. Pre-Functional checklists are employed to verify that the equipment and systems are fully

connected and operational. Installation elements of the checklists for a given system must be successfully completed and approved prior to startup. Contractors assert completion of installations; CA verifies contractors' assertions.

- B. Equipment startups are performed by responsible contractors and/or factory authorized technicians as required by pertinent specification sections. The primary role of the CA in the start-up process is to ensure that there is written documentation that each of the specified start-up requirements or the manufacturer-recommended procedures has been completed. Successful start-ups shall be documented on the Functional Performance Checklists.
- C. Execution of Pre-Functional Checklists and Startup
1. The pre-functional checklists will be provided by the CA at the Post Submittal Commissioning Meeting. A sample checklist is provided at the end of PART 3 in this section and is indicative of required procedures to be executed as part of startup and initial checkout of the systems and the parties responsible for their execution. The sample pre-functional checklists will be honed responsive to approved submittals.
 2. The execution and approval of the pre-functional checklist and startup shall be directed and performed by the contractor, subcontractor or vendor. Signatures are required of the applicable subcontractors for verification of completion of their work.
 3. The contractor/subcontractor responsible for the purchase of the equipment shall develop the full startup plan by combining the manufacturer's detailed startup and checkout procedures and the construction checklists and document the successful start-up. CA shall verify successful startup documentation.
 4. The contractor shall coordinate startup and checkout with the Loudoun County PM, AE, and CA. In general, CA will witness startup of all major pieces of equipment, and in particular those that are required to be started by manufacturer's personnel. A sampling strategy will be used for witnessing startup of multiple similar pieces of equipment.
- D. Deficiencies, Non-Conformance, and Approval in Checklists and Startup (Issues Log).
1. During the commissioning process, the Commissioning Agent may identify issues that require corrective action. The Commissioning Agent has no authority to dictate ways and means of issues resolution other than enforcing the dictates of Contract Drawings and Specifications. Resolution of issues that require interpretations or modifications to the contract documents shall be the responsibility of the Architect and Engineers. Project completion date shall not be delayed due to lack of timely issues resolution unless authorized contract extensions have been executed.
 2. Written responses shall be made to issues reported by the Commissioning Agent. The Commissioning Agent shall provide status reports and issues logs as deemed appropriate during the commissioning process with original provided to Loudoun County PM and copies to the General Contractor, and Architect. The General Contractor and/or Architect shall provide the Loudoun County PM with a written response to each issue cited by the Commissioning Agent as to corrective actions implemented. The written response shall be provided to the Loudoun County PM within two (2) weeks of the date of the Commissioning Agent's issues citing correspondence; copies shall be provided to the Commissioning Agent, General Contractor, and Architect. Issues that have not been fully resolved within the two week period shall be noted as such with explanation of intended resolution; and subsequent status reports of the continued issue resolution shall be made in writing at two week intervals until such time as the issue has been fully rectified. The Loudoun County PM reserves the right to withhold partial payment for construction contract or professional services until satisfactory resolution

of mechanical issues have been documented and verified.

3.5 OPERATIONS AND MAINTENANCE MANUALS

- A. The commissioning process requires detailed O&M documentation as identified in this section in PART 4, Section 01 91 13, and technical specifications.
- B. Operating and Maintenance Manuals shall be provided to the Architect/Engineer for review no later than sixty (60) days after the last submittal/shop drawing has been approved. AE shall provide the Operating and Maintenance Manuals to the Commissioning Agent after the AE's review. The Manuals with AE and Commissioning Agent's review comments will be returned to the Contractor for preparation for use in training of Loudoun County's operating and maintenance personnel. Return of the reviewed Manuals shall be approximately six weeks after Contractor submission.
- C. Manuals format and content shall be as specified in Section Division 01, Section 017823.

3.6 DEMONSTRATIONS AND TRAINING

- A. The contractor shall provide demonstrations and training in accordance with the technical specification sections, PART 4 of this specification section, and Divisions 22, 23 and 26.
- B. Demonstration and training plan shall be submitted to the Commissioning Agent at the time of submission of the Operation and Maintenance Manuals. Plan shall fully detail all demonstrations and trainings that are to be provided by the Contractor to Loudoun County's operating and maintenance personnel and include a time allocation schedule. Actual dates and times, if used, shall be understood as tentative and subject to change based upon actual construction progress. However, at a minimum, the Demonstration and Training schedule shall include time allocations (i.e. hours) for each piece of equipment or system for which demonstration and training are specified. Commissioning agent review comments will be provided when Operating and Maintenance Manuals are returned to the Contractor. The plan shall cover the following elements:
 - 1. Equipment/system
 - 2. Intended audience
 - 3. Location of training
 - 4. Subjects covered (description, duration of discussion, special methods, etc.)
 - 5. Methods (classroom lecture, manufacturer's quality video, site walk-through, actual operational demonstrations, written handouts, etc.).
- C. The O&M manuals shall be incorporated into all training sessions.
 - 1. Use the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - 2. Review the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
 - 3. Discussion of relevant health and safety issues and concerns.
 - 4. Discussion of warranties and guarantees.
 - 5. Common troubleshooting problems and solutions.
 - 6. Discussion of any peculiarities of equipment installation or operation.

- D. The majority of training and demonstrations shall precede Performance Verification; some training, such as use and operations of the automation system, occurs during and after performance verifications.
- E. The CA participation in demonstration and training is to verify and document that training has been given to the satisfaction of Loudoun County's operating and maintenance personnel. The CA may amplify the training sessions by explaining design concepts and systems interactions.

3.7 PERFORMANCE VERIFICATION

- A. Requirements: Performance verification shall demonstrate that each system is operating according to the design intent and contract documents. Performance verification facilitates bringing the systems from a state of individual substantial completion to full dynamic operation. All major systems, such as energy recovery units, DX rooftop units, and heating and ventilating units shall have performances verified by the CA. Systems involving multiple, repeated equipment, such as VAV terminals, fan coil units, room lighting control, shall be verified by sampling.
- B. Coordination and Scheduling: The contractor shall provide sufficient notice, regarding their completion schedule for the pre-functional checklists and startup of all equipment and systems to allow the performance verification to be scheduled. The commissioning team shall oversee, witness, and document the performance all equipment and systems. The CA in association with the contractor/subcontractors and facility staff shall execute the verifications.
 - 1. Performance verification shall be conducted after the pre-functional checklists and startup has been satisfactorily completed.
 - 2. For HVAC systems, air balancing and water balancing shall be completed and all systems shall be operating under automation system control programming (automatic control) prior to performance verification.
 - 3. Performance verification proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems shall be verified.
- C. Procedures. CA will provide detailed performance verification procedures and forms after all submittals, including controls, have been approved. A sample of the Functional Performance checklist is provided at the end of PART 3 in this section. Equipment performance shall be tested or verified per the parameters and requirements of the pertinent technical specifications and/or manufacturers' recommendations. Systems performances shall be verified per procedures of pertinent technical specifications, including Testing and Balancing of Division 23, and as further amplified by the CA.
 - 1. Performance testing and verification may be achieved by manual testing or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by stand-alone data loggers. The CA may substitute specified methods or require an additional method to be executed other than what was specified, with the approval of the AE and Loudoun County PM. The CA will determine which method is most appropriate for tests that do not have a specified method.
 - 2. Performance verification and testing shall be performed under design conditions as closely as is practically possible. Simulation of design conditions may be employed to verify performance. When simulation is used, the actual results may also require re-verification under design load conditions.
 - 3. The Installing Contractor shall operate all equipment and systems in support of the commissioning work effort and shall provide all labor, equipment, and materials necessary to

allow operational and performance verification of all commissioned equipment and systems.

D. Non-Conformance.

1. Corrections of minor deficiencies identified may be made during performance verification at the discretion of the CA. In such cases the deficiency and resolution will be documented on the procedure form or on an attached sheet.
2. As tests progress and a deficiency is identified that cannot be immediately rectified, the CA shall discuss the issue with the commissioning team:
 - a. When there is no dispute on the deficiency and the contractor accepts responsibility to correct it, the CA will document the deficiency in the Issues Log. After the contractor acknowledges correction of the deficiency in writing in the Issues Log, the contractor shall reschedule the test; and the test shall be repeated.
 - b. If there is a dispute about a deficiency, regarding whether it is a contractor issue or a design issue:
 - 1) The apparent deficiency shall be documented in the Issues Log.
 - 2) The deciding responsible party shall indicate the resolution on the Issues Log and the performance verification shall be repeated responsive to the resolution.
3. The contractor shall acknowledge in writing the status of each outstanding discrepancy identified in the Issues Log. A two-week time interval shall be allowed between the date of issuance of the Issues Log and the contractor's response. Where deficiencies have not been rectified within the allotted two weeks, contractor's response shall provide explanations.
4. Failure Due to Manufacturer Defect: If 10% (or three, whichever is greater) of identical pieces of equipment fail to perform to the contract documents (mechanically or substantively) due to a manufacturing defect, not allowing it to meet its submitted performance specification, all identical units may be considered unacceptable by the AE or CA. In such case, the contractor shall provide the Loudoun County PM with the following:
 - a. The contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be signed and dated, with a written explanation of the problem, cause of failures, etc., and all proposed solutions.
 - b. The AE will determine whether a replacement of all identical units or a repair is acceptable.
 - c. Performance verification shall be repeated after all repairs/replacements have been completed.

E. Deferred Performance Verification

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

- F. Costs for Re-Testing: Contractor is responsible for costs of performance verification. The cost of the work of the CA is covered by the Loudoun County PM. However, where re-testing of a system is required due to a deficiency having been cited and the re-test again fails due to un-rectified deficiencies, the costs of the CA associated with all subsequent re-testing may be withheld from Loudoun County's payment to the contractor. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the contractor.
- 3.8 RECOMMENDED ACCEPTANCE: The CA notes each satisfactorily demonstrated function on the performance verification forms. CA provides all forms in the final commissioning manual delivered to the Loudoun County PM with an executive summary recommending acceptance of the installation as complete and operating in accordance with contract requirements. Recommendation of acceptance may be conditional where:
- A. The vast majority of the work was found to be installed and operating per contract requirements, but some minor deficiencies remain. Final acceptance would be predicated upon the condition that all known deficiencies have been corrected and accepted by the Loudoun County PM.
 - B. The HVAC system may be conditionally accepted in the initial season of operation, with the condition that the operations in the opposite season must meet performance verification. Final acceptance of the HVAC system requires two seasons (i.e. heating season and cooling season) performance verification.
- 3.9 VERIFICATION CHECKLIST: The following sample checklist is representative of those that will be generated by the CA for Commissioned systems. CA will submit Pre-Functional checklist forms for all equipment/systems during the construction phase.

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COMMISSIONING VERIFICATION TEST FORM
 DEDICATED OUTDOOR AIR SYSTEM
 DOAS-1



PROJECT	STERLING COMMUNITY CENTER 120 ENTERPRISE ST. STERLING, VA 20164	MANUFACTURER	
TEST DATE		MODEL NO:	
INSTALLING CONTRACTOR		COMMISSIONING AUTHORITY	DEI Consulting

Verification Checklist Items	DOAS-1	
	Contractor	Cx Auth. Y/N
A. General		
1 Approved submittals have been received.		
2 Equipment nameplates has been installed.		
3 Unit nameplate matches approved submittals.		
4 Shipping and installation materials have been removed.		
5 Unit is free of any visible defects		
6 Unit operation and maintenance manuals have been received.		
7 Equipment warranty papers have been received.		
B. Unit Setting And Installation		
1 Vibration isolation have been installed.		
2 Unit is accessible for maintenance		
3 Equipment identification label is installed		
4 Intake air filters and spare air filters have been provided		
5 Dampers have been provided.		
6 Access to other equipment is not impeded		
7 Components can be isolated for maintenance		
8 Indicators are accessible and can be read		
9 Emergency switches/alarms are installed in visible location		
C. Gas Piping		
1 Gas piping and valves are installed		
2 Gas piping is installed according to specifications		
D. Electrical		
1 Unit power wiring is completed per specifications.		
2 Unit is ready for start-up and operational testing.		
E. Controls		
1 Unit controls are properly installed.		
2 Installation and control sequences are complete.		
F. Start-up		
1 Unit is ready for start-up.		

The above Verification Test has been performed by the Contractor and Verified by the Commissioning Authority:

Contractor representative:	Commissioning Authority:
_____	_____
Signature	Signature
_____	_____
Print Name and Title	Print Name and Title
_____	_____
Date	Date

3.10 FUNCTIONAL PERFORMANCE VERIFICATION: The following sample Performance Verification form is representative of those that will be generated by the CA for commissioned systems: Project specific forms will be prepared after all submittals, particularly the temperature controls submittals,

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have been approved.



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 DEDICATED OUTDOOR AIR SYSTEM
 DOAS-1**



PROJECT	STERLING COMMUNITY CENTER 120 ENTERPRISE ST. STERLING, VA 20164	MANUFACTURER	
TEST DATE		MODEL NO.	
INSTALLING CONTRACTOR		COMMISSIONING AUTHORITY	DEI Consulting

A. Parties Responsible to Execute Functional Test

1. HVAC contractor: To operate and activate equipment as needed.
2. Controls contractor: Operate the controls to activate the equipment.
3. CA: To witness, direct, and document testing.

B. Prerequisites

1. Unit Verification Test Forms Have Been Successfully Completed.
2. Unit Startup Has Been Completed By Manufacturer & Startup Forms Have Been Provided.
3. Unit Controls have Been Completed And All Control Functions Are Operable.
4. Testing & Balancing (TAB) Contractor Has Finished TAB And Ready For Functional Testing.
5. All AHU Graphical And Control Functions Are On The Screen And Operating As Intended.

C. Functional Performance Check List

Proc. No.	Test Procedure	Expected Response	DOAS-1 Pass Y/N
1	Check programming to verify RTU-1 occupied schedule	Program indicates unit occupied scheduled betweenam topm	
2	Verify un-occupied setback programming Cooling at 85°F	Programming indicates 60°F and 85°F for heating and cooling respectively	
3	Verify programming morning warm-up and cool-down to maintain 70°F space temperature	Program indicates 70°F space temperature for morning warm-up and cool-down	
4	Raise discharge static pressure and differential pressure	Supply fan VFD shall speed up to maintain higher set point	
5	Drop discharge air pressure and differential pressure	Supply fan VFD shall speed down to maintain lower set point	
6	Raise damper position of a VAV box to 98%	Duct static pressure shall be reset to a higher value 5% higher than the original max. set point	
7	Reset building pressure setpoint to higher and lower set points from 0.05	Exhaust fan VFD shall increase and decrease speed respectively to maintain new setpoint	
8	With OA enthalpy lower than return enthalpy and OA temperature, at least 1.5°F below RA and above DA setpoint	Return and DA dampers fully opened and return fully closed	

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 DEDICATED OUTDOOR AIR SYSTEM
 DOAS-1**



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TEST DATE		MODEL NO.	
INSTALLING CONTRACTOR		COMMISSIONING AUTHORITY	DEI Consulting

9	OA temperature below DA setpoint during economizer mode	RA, OA, and return air dampers modulate to maintain DA setpoint	
10	During non economizer mode (htg/colg) change parameter to change positions of all dampers	At all conditions OA dampers modulate to maintain min. OA CFM and supply air monitoring station	
11	As RAT varies from 75°F to 70°F	DAT setpoints vary proportionally from 60°F	
12	Reset CO2 level higher and lower setpoints	CO2 setpoints shall adjust to maintain new CO2 setpoint levels	
13	Reset CO2 level to a substantially lower setpoint	CO2 shall initiate alarm	
14	Set unit to unoccupied mode	Fan, dampers and all valves shall shut-down/close	
15	Return all changed control parameters and conditions to their Pre-Test values		

D. Safety Mode Test

Proc. No.	Procedure	Expected Response	DOAS-1 Pass (Y/N)
1	Smoke detection indicated	Fans shall shut down and fire alarm system initiated	
2	Water differential pressure	Alarm signal initiated at BMS	
3	Low OA temperature freeze protection	Alarm signal initiated at BMS	
4	CO2 alarms	Alarm signal initiated at BMS	
5	Return all changed control parameters and conditions to their Pre-Test values	Check off in above Section when completed	

E. Acceptance Criteria

- For the conditions, sequences, and modes tested, the unit, integral components, and related equipment respond to changing conditions and parameters appropriately as expected, as specified and according to acceptable operating practice.

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DOAS-1



PROJECT	STERLING COMMUNITY CENTER 120 ENTERPRISE ST. STERLING, VA 20164	MANUFACTURER	_____
TEST DATE	_____	MODEL NO.	_____
INSTALLING CONTRACTOR	_____	COMMISSIONING AUTHORITY	DEI Consulting

FOR FOLLOW-UP ON ALL OPEN ITEMS SEE COMMISSIONING DEFICIENCY LOGS.

The above Functional Test has been observed by the Commissioning Authority:

Commissioning Authority

_____ Signature

_____ Print Name and Title

_____ Date

SAMPLE

PART 4 – REQUIREMENTS

4.1 MECHANICAL OPERATION AND MAINTENANCE MANUALS

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General Contractor to provide operation and maintenance manuals for review as noted on PART 3.5 of this section, and prepare documents as follow,

A. Operating and Maintenance Manuals:

1. Initial preparation shall be made by the Mechanical Trade Representative.
2. Quantity: provide three (3) copies of the manual: Owner set DCWM, General Services set and Building set.
3. Format: 3" thick, 8-1/2" x 11 loose leaf binders. Provide as many as required. Binders shall not be overloaded.
4. Each major heading in the table of contents shall have a large distinctive, clearly marked, non-erasable, plastic encased tab.
5. Each section shall have the sub-tabs. Sub-tabs shall be similar to the main tabs but of a different color.
6. Contents:
 - a. Cover sheet. The cover sheet shall list: project name, location, names of the project manager, architect, structural engineer, mechanical engineer and electrical engineer, name of the firms, address and telephone number.
 - b. Table of contents.
 - c. Description of systems: The description of systems shall be provided by the Commissioning Agent at the time of review and before turn-over to the Owner. This description of systems shall be a comprehensive overview of the entire system. Simplified professionally drawn system diagrams shall be provided on 8-1/2"x11" or 11" x 17" sheets. These shall include chilled water system, condenser water system, heating hot water system, supply air systems and exhaust systems. These shall show major pieces of equipment such as pumps, chillers, boilers, control valves, expansion tanks, coils, service valves, etc. Copies of these diagrams shall be framed under plexiglass and mounted in an appropriate place. Framing and mounting shall be the responsibility of the mechanical Trade Representative. These will be the basis for the starting of the Owner's instruction program.
 - d. Design parameters: The design parameters will be provided by the Engineer of Record as part of the Owner's Project Requirements. It will be a detailed listing of the design criteria on a room by room and system by system basis used as a basis for the design. This will be inserted by the Engineer of Record at the time of review and before turnover to the Owner.
 - e. Specifications: The specification shall be copied and inserted complete with all addenda.
 - f. Submittal and Product Data: This section shall include all approved submittal data. If submittal was not required for approval, descriptive product data shall be included.
 - g. Installation Instructions: If the product, such as pipe, etc., does not have any written installation instructions, include a statement "Manufacturer's Written Installation Instructions not Available - Product Installed in Accordance with Specifications and Good Practice".
 - h. Operation and Maintenance Instructions: These shall be the written manufacturer's data edited to omit reference to products or data not applicable to this installation.
 - i. Parts List: These shall be edited to omit reference to items which do not apply to this installation.

- j. Equipment Supplier: This section shall include the name, address and telephone number of the manufacturer's agent and/or service agency supplying or installing and starting up of the equipment.
- k. Commissioning Checklist: This will be filled out by the Contractor with the specified data and submitted data and inserted into the manual for submission to the Engineer of Record. A copy shall be given to the test, adjust and balance (TAB) Trade Representative so that (TAB) data can be added. Upon completion of this entry, the form shall be forwarded with the certification of system completion and commissioning request.
- l. System Description: This section shall include that portion of the overall description included in the beginning of the manual as it applies to each sub-section. In sections such as pipe, valves and fittings, a statement shall be included. In sections such as pumps, the pump designations and their use shall be listed as included in the equipment schedule such as:

Hot Water Heating Pumps

Complete Hot Water System Description.

- m. Controls Description: This will be included in each section covering controlled equipment. It will include the description from the approved temperature control submission, complete with schematic diagram showing piping arrangement and control location on 8-1/2" x 11" or 11" x 17" sheet. This data shall be provided by the DDC Trade Representative in a form suitable for insertion into the O&M Manuals by the Mechanical Trade Representative and for review by the Engineer of Record such as:

VRF indoor units

VRF outdoor unit

ERU

Fans

Unit heaters

DX Split systems, etc

A copy of these control diagrams shall be framed under plexiglass, and mounted next to the controlled equipment or in an appropriate place by the DDC Trade Representative.

- n. Condensed Operating Instructions:

This section shall include condensed instructions for start-up, shut-down, emergency operation, safety precautions, unusual features and troubleshooting suggestions. Where control is clearly covered in controls description, it is not to be duplicated here.

A copy of these instructions shall be framed under plexiglass, and placed adjacent to the equipment where they can be easily read by operating personnel. Instructions mounted outdoors shall be suitably weather protected. Framing and mounting shall be the responsibility of the mechanical Trade Representative. These instructions shall be provided for boilers, pumps, air handling units, exhaust fans, air terminal units and controls.

- o. Preventative Maintenance Instructions: This section shall include condensed typewritten excerpts from the manufacturer's written instructions on weekly, monthly, quarterly, annually, etc. This summary shall be prepared by the mechanical Trade Representative with help from the equipment supplier. It will be reviewed by the Engineer of Record prior

to turning over to the Owner. It shall be prepared for all items listed under "Condensed Operating Instructions" above.

p. Section 014520 – Testing, Adjusting and Balancing shall contain the following sections:

- Specifications.
- Submittals. All shall be completed, provide copies of logs.
- TAB Data. This shall be the final TAB data. It will probably have to be added after the owner has received his training and the O&M manuals. Payment for TAB work will be withheld until the data is received and approved and the TAB instructed session is complete. The Mechanical Representative will be responsible for incorporating this data into the O&M manuals.

q. Commissioning of HVAC System shall contain the following sections:

Specifications

Commissioning Plan

Final Report of the Owner

r. Include a section with copies of all the completed start-up forms for equipment including the ERU, VRF, ACs etc. Also include all certified test forms including the duct leakage & pipe pressure test.

7. Submittal Requirement:

- a. The O&M manuals shall be submitted at the equipment placement completion stage, which shall be defined as that time in the project when the major pieces of equipment have been set in place ready for connection to piping and duct systems.
- b. In order to ensure that the O&M manuals are submitted in timely manner and to give a reasonable time for compliance, any progress payments for Division 23 work beyond 60% of scheduled value shall not be approved until this submittal has been received and provisionally approved.

4.2 TRAINING OF OWNERS OPERATORS:

- A. General Contractor shall have a professional videographer digitally record video and audio of each instruction and training session, including the sessions specified below and added sessions required in the technical sections for specialized equipment. The videographer shall provide wireless microphones for attachment to the person performing the training so that the audio is of high quality. The videographer shall also provide tripods and lights as necessary so that all portions of the training can be filmed in high quality. Provide one complete set of DVDs with each Operating and Maintenance Manual. Any portion of the recording deemed inaudible or of poor video quality by the Loudoun County PM shall be recorded again at no expense to the Loudoun County.
- B. The owners shall be given comprehensive training in the understanding of the systems and the operation and maintenance of each major piece of equipment.
- C. The General Contractor will be responsible for scheduling the training which shall start with classroom sessions followed by hands on training on each piece of equipment. Hands on training shall include start-up, operation in all modes possible, shut-down and any emergency procedures. The training schedule shall be submitted to the Owner and Engineer of Record for approval 30 days after approval of the O&M manuals.

- D. Training shall include the following sections: system orientation, maintenance, operation and inspection.
 - E. The second, or equipment portion, shall be scheduled as soon as possible after start-up of the equipment.
 - F. The third portion, or the TAB and commissioning portion, shall be conducted after completion of this work.
 - G. Classroom sessions shall include the use of overhead projections, slides, video and audio taped material as might be appropriate.
 - H. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual.
 - I. The Engineer of Record will conduct the first session on the overall system design concept and the design concept portion of each equipment section.
 - J. The manufacturer's representative shall provide the instructions on each major piece of equipment. These sessions shall use the printed installation, operation and maintenance instruction material included in the O&M manuals and shall include a review of the written O&M installations emphasize safe and proper operating requirements and preventative maintenance. Training will be included for all major pieces of equipment including pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, air terminals, controls and water treatment systems. Equipment training shall be done by qualified service engineers employed by the manufacturers or their qualified sales representatives. The orientation and inspection function of the equipment in the system shall be discussed.
 - K. Each classroom training session shall be followed by an inspection, explanation and demonstration of the equipment. The start-up and shut-down modes of operation shall be demonstrated.
 - L. The Contractor shall attend all sessions and shall add to each session any special information relating to the details of installation of the equipment as it might impact the operation and maintenance.
 - M. The temperature controls Trade Representative shall attend all sessions and be prepared to conduct the controls portion of the training as it relates to each equipment section.
 - N. The DDC Trade Representative shall conduct the training session on the controls system hardware and software.
 - O. The piping, insulation and sheet metal Trade Representatives shall conduct sessions on their respective trades with emphasis on any peculiarities of the systems, pressure limitations and maintenance requirements.
 - P. The TAB Trade Representative shall conduct a training session reviewing the procedures and methods used in the TAB process, shall review the TAB data and shall demonstrate use of test equipment which may have been turned over to the owner and shall point out the locations of all pitot traverse locations for the owner's future use.
- 4.3 NOTIFICATION OF SYSTEM COMPLETION AND REQUEST FOR FINAL HVAC SYSTEM COMMISSIONING VERIFICATION
- A. When systems are ready for final commissioning verification, the mechanical Trade Representative shall notify the Owner in writing.
 - B. Should the verification test reveal that the equipment is not performing as specified or control operation is not acceptable, the Contractor will be entitled to one re-inspection of any failed item at

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no additional cost.

- C. Should the verification test determine that the equipment is still not performing as specified or control operation is not acceptable on the second inspection, the time and expenses of the Engineer of Record if applicable, and Owner to make further verification shall be considered as additional cost to the Owner. The total sum of such costs shall be deducted from the final payment to the Contractor.

END OF SECTION 019113

SECTION 019118 – BUILDING ENVELOPE COMMISSIONING (ADDENDUM NO. 4)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. The requirements of this Section apply to all sections of Divisions 2 through 9.
- B. Commissioning consists of systematically documenting that specified components and systems have been installed and started up properly and then functionally tested to verify and document proper operation through all sequences of operation and conditions. In addition, training of the Owner's Operations Personnel will be verified and final project O&M Documents will be reviewed for completeness.
- C. This Section includes exterior enclosure commissioning procedures, including substructure, superstructure, exterior enclosure, and roofing construction that protects climate-controlled interior spaces from unconditioned spaces and the exterior environment, as follows:
 - 1. Superstructure floor and roof construction that functions as part of the exterior enclosure system.
 - 2. Exterior enclosure construction, above grade, including exterior opaque walls, windows, and doors including sheathing, framing, and insulation, and interior finish materials attached to the exterior wall, and air barriers.
 - 3. Roofing, including roofing system, roofing insulation, and skylights, hatches, and other roof openings.
 - 4. Interface conditions (flashings, expansion joints, and sealant) between each of the materials, components and systems that comprise the above and below grade building exterior enclosure

1.3 QUALITY ASSURANCE

- A. Quality Assurance and Control: Specific commissioning quality-assurance and – control requirements for individual construction activities are specified in the Sections that specify those activities. Specified commissioning tests, inspections, and related actions do not limit Contractor's other quality-assurance and -control procedures that facilitate compliance with the Contract Document requirements.
- B. Preconstruction Commissioning Conference: Commissioning Authority will schedule a preconstruction commissioning conference before construction of the exterior enclosure starts, at a time convenient to Owner, Construction Manager/General Contractor, Contractor, and Architect, but no later than 15 days after execution of the Agreement with the Contractor. Allow for the conference to be held at Project site or another convenient location. The Commissioning Authority will conduct the meeting to review commissioning responsibilities and personnel assignments.
 - 1. Attendees: Authorized representatives of Owner, Construction Manager/General Contractor, Commissioning Authority, Architect and consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference. All participants at the conference shall be familiar with Project and authorized to conclude matters relating to commissioning.

2. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Owner's Project Requirements (OPR)
 - b. Commissioning plan.
 - c. Tentative construction schedule.
 - d. Phasing.
 - e. Critical work sequencing and long-lead items.
 - f. Designation of key personnel and their duties.
 - g. Procedures for testing and inspecting.
 - h. Submittal procedures.
 - i. LEED requirements.
 - j. Preparation of Record Documents.
 - k. Owner's occupancy requirements.
 - l. Security.

3. Minutes: Building Envelope CxA will record and distribute meeting minutes.

1.4 DEFINITION

Refer to Section 019113 General Commissioning Requirements for definitions.

1.5 COMMISSIONED SYSTEMS

- A. Commissioning of a system or systems specified in Division 01,03,04,07 and Division 08 are part of the construction process. Documentation and testing of these systems, as well as training of the Owner's Operation and Maintenance personnel, is required in cooperation with the Owner and the Commissioning Agent.

- B. The following Facility exterior closure systems will be commissioned:
 1. Roofs (modified bituminous, single-ply, fluid-applied, flashing & sheet metal, metal roofing, roof specialties, and roof accessories)
 2. Curtain Wall Systems (Mullions, glazing, and sealing)
 3. Exterior Doors (Revolving, glass leaf, emergency exit, and service)
 4. Exterior Windows (Aluminum, steel, glazing, storm)
 5. Sealants (Caulking, mechanical seals, and wind and vapor barriers)
 6. Air Barriers (fluid-applied membranes, sheet applied membranes, through-wall flashing, transition membranes, penetrations)

1.6 RELATED WORK

- A. Related Specification sections
 1. Section 014100 COORDINATION, FIELD ENGINEERING & REGULATORY REQUIREMENTS
 2. Section 019113 GENERAL COMMISSIONING REQUIREMENTS
 3. Section 072650 LIQUID-APPLIED VAPOR PERMEABLE AIR BARRIER SYSTEM
 4. Section 075300 TPO SINGLE PLY ROOFING
 5. Section 079000 SEALANTS
 6. Section 081000 METAL DOORS AND FRAMES
 7. Section 084000 ALUMINUM ENTRANCES AND STOREFRONTS
 8. Section 085200 ALUMINUM HUNG WINDOWS

- B. Enclosure Testing Matrix (Section 3.13)
- C. Contractor QA/QC Testing reports.
- D. Close-out documentation including O&M Manuals.
- E. Reference Codes and Standards
 - 1. AAMA 502 - Voluntary Specification for Field Testing of Newly Installed Fenestration Products/
 - 2. AAAM 503 - Voluntary Specification for Field Testing of Newly Installed Storefronts, Curtain Walls, and Sloped Glazing Systems
 - 3. ASTM E488 - Standard Test Methods for Strength of Anchors in Concrete Elements
 - 4. ASTM E783 - Standard Test Method for Field Measurement of Air Leakage through Installed Exterior Windows and Door
 - 5. ASTM E779 - Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
 - 6. ASTM E1827 - Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
 - 7. ASTM C794 - Standard Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants
 - 8. ASTM C1153 - Standard Practice for Location of Wet Insulation in Roofing Systems Using Infrared Imaging
 - 9. ASTM C1060 - Standard Practice for Thermographic Inspection of Insulation Installations in Envelope Cavities of Frame Buildings
 - 10. ASTM C1193 Appendix 1 - Standard Guide for Use of Joint Sealants
 - 11. ASTM D4541 - Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers
 - 12. ASTM D 7877 - Standard Guide for Electronic Methods for Detecting and Locating Leaks in Waterproof Membranes
 - 13. ASTM E 1105 - 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
 - 14. ASTM D5957 - Standard Guide for Flood Testing Horizontal Waterproofing Installations
 - 15. ASTM E2813 - Standard Practice for Building Enclosure Commissioning

1.7 SUBMITTALS

- A. The Contractor is to provide the following submittals to the Commissioning Authority, in addition to submitting them to the Architect-of-Record. These submittals are in addition to those specified in Division 1 Section 019113, General Commissioning Requirements.
 - 1. Preconstruction Test Reports: all preconstruction air and water leakage performance test results, including all failed tests, recording the noted deficiency and the required repair, and provide a copy of all remediation processes and QC/QA processes that will be put in place to address the deficiency on future work product.
 - 2. Source Quality Control Reports: retain a copy for field review by the commissioning authority and include in the closeout submittal a copy of all manufacturer QA/QC reports submitted for products supplied for the project
 - 3. Field Quality Control Reports: provide a copy of the test reports for all field water and air penetration and other appropriate building exterior enclosure tests completed
 - 4. Special Inspections Reports for all special inspections indicated by the Architect/Engineer-of-Record in the specifications.

1.8 DESCRIPTIONS

- A. This Section includes requirements for commissioning the Facility exterior closure, related subsystems and related equipment. This Section supplements the general requirements specified in Section 019113, General Commissioning Requirements.
- B. The commissioning activities have been developed to support the Owner requirements to meet guidelines for ASTM 2813 Standard Practice for Building Enclosure Commissioning, and Federal Leadership in Environmental, Energy, and Economic Performance.
- C. Refer to Section 019113, General Commissioning Requirements for more details regarding processes and procedures as well as roles and responsibilities for all Commissioning Team members

PART 2 - PRODUCTS

2.1. PRE-FUNCTIONAL AND FUNCTIONAL PERFORMANCE TESTING EQUIPMENT AND INSTRUMENTS

- A. The Building Envelope CxA shall furnish all special tools and equipment required during the entire commissioning process. The contractor shall provide support, tools and equipment to be used during commissioning, which shall be submitted to the Commissioning Authority for approval. The owner shall furnish necessary utilities for the commissioning process.
- B. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the owner upon completion of the commissioning process.

PART 3 - EXECUTION

3.1. GENERAL

- A. The Contractor shall complete all phases of work so the systems can be cured, sealed, and made weathertight and tested per the contract documents and related directives, clarifications, and change orders.

3.2. PARTICIPATION IN ACCEPTANCE PROCEDURES

- A. The Contractor shall provide representatives from the enclosure trades to be available to assist the Commissioning Authority in completing the commissioning program. Work schedules, time required for testing, etc., shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.
- B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.
- C. The Commissioning Authority reserves the right to question the appropriateness and qualifications of the technicians relative to each item of enclosure system. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Contractor shall provide adequate documentation to test the enclosure system including but not limited to contract documents and submittals.

3.3. TESTING VERIFICATION

- A. At substantial completion of the project The General Contractor/Construction Manager is to:
1. Certify that building exterior enclosure systems, subsystems, and construction have been completed according to the Contract Documents, including all addenda and change order requirements.
 2. Certify that Field Quality Control procedures have been completed, and that field quality control reports have been submitted, discrepancies corrected, and corrective work approved. Provide a copy of the list of non-conformances maintained by the General Contractor/Construction Manager indicating all rework and corrections completed.

3.4. DEFICIENCY RESOLUTION

- A. In some systems, deficient performance under various tests will result in additional work being required to commission the systems. This work shall be completed under the direction of the Owner, with input from the contractor, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Owner and/or Architect shall have final jurisdiction over any additional work done to achieve performance.
- B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. The Commissioning Authority shall notify the Owner, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor's responsibility.

3.5. ADDITIONAL COMMISSIONING

- A. Additional commissioning activities may be required after remediation, replacements, etc., are completed. The contractor(s), suppliers, and Commissioning Authority shall include a reasonable reserve to complete this work as part of their contractual obligations.

3.6. CONTRACTORS TESTS

- A. Contractor tests as required by other sections of Division 07 or Division 08 shall be scheduled and documented in accordance with Section 010000 General Requirements. The Commissioning Agent will witness selected Contractor tests. Contractor tests shall be completed prior to scheduling Systems Functional Performance Testing.

3.7. FUNCTIONAL PERFORMANCE TESTING

- A. The Building Envelope CxA is to provide all tools, plastic wrap, test chambers, tape, water pumps, hoses, instruments, laptop computers, PDA's, software programs and services required to perform all referenced testing standards listed with in this specification or on the testing matrix. This includes providing the connection to systems to be tested, operation of the test equipment & instrumentation and generating test results as required. If there is a conflict between this specification and other specifications the greater number of tests shall need to be priced and executed.
- B. The Contractor is to provide the following items, as required by the tests listed below, for the third-party testing company use.
1. Scaffolding and/or access to elevated working surfaces.

2. Water source or tank within 150' of the testing chamber, sized to provide the specified water pressures, 30-35psi.
3. Power for the testing agency equipment. Minimum 120-volt 20-Amp dedicated circuit within 100' of the test chamber.

3.8. SYSTEM PRE-TEST CHECKLIST

- A. Prior to the building air tightness testing, the following shall be provided as part of a pre-test checklist:
1. The Architect shall provide the total building surface area (square feet) calculation (including Roof, walls and floors).
 2. Contractor shall seal or otherwise effectively isolate all "intentional" holes in the building enclosure. This includes air intake or exhaust louvers, make-up air intakes, pressure relief dampers or louvers, dryer and exhaust vent dampers and any other intentional hole that is not included in the air barrier design or construction. Intentional openings can be sealed by using an air-tight film or by motorized or manual dampers held in the closed position.
 3. Contractor shall confirm plumbing traps are filled with water.
 4. Contractor shall make sure the HVAC system is shut down or disabled for the duration of the test.
 5. Contractor shall make sure dampers in the envelope perimeter are closed and/or isolated.
 6. Contractor shall make sure that combustion equipment must be disabled or be in the "pilot" position.
 7. Contractor shall make sure exhaust fans and dryers are off and isolated at the air barrier.
 8. Contractor shall make sure exterior windows and doors are in the closed and locked position.
 9. Contractor shall remove door closers at exterior door opening(s) where blower door equipment is to be set up.
 10. Contractor shall make sure all interior doors that access the building enclosure (roof, walls and fenestrations, floor) must be held open during the test to create a single uniform zone. If the door services only an interior room such as a storage closet, it is allowed to remain closed only if a dropped ceiling plenum is present above and it does not access an air barrier boundary.
 11. Contractor shall make sure buildings with a dropped ceiling plenum must have tiles removed at a rate of one per every 500 sq. ft. (Additional tiles may be removed at the discretion of the testing agency so a uniform pressure distribution in the plenum space is achieved.)
 12. Contractor shall make sure top plates and wall-to-ceiling connections are sealed at the attic.
 13. Contractor shall make sure service penetrations are sealed and air sealing is in place behind or around shower/tub enclosures, electrical boxes, switches and outlets on the exterior walls.
 14. Contractor shall make sure Junction of foundation and bottom wall plate is sealed.
 15. Contractor shall make sure penetrations through bottom of wall plate are sealed.
 16. Contractor shall make sure space between window/door jambs and framing is sealed.
 17. Contractor shall make provide one 110V, 15 or 20 amp electrical outlet per fan on separate circuits in proximity to the fan set-up location.
 18. Contractor shall arrange for representatives from mechanical, electrical and general contractors to be present during testing.

3.9. SYSTEM FUNCTIONAL PERFORMANCE TESTING

- A. The Commissioning Process includes Systems Functional Performance Testing that is intended to test systems functional performance. The Construction Manager/General Contractor shall review and comment on the tests prior to approval. The Building Envelope CxA shall provide the required labor, materials, and test equipment identified in the test procedure to perform the tests. The

Commissioning Agent will witness and document some of the testing. The Construction Manager/General Contractor shall sign the test reports to verify tests were performed.

- B. One test, for each system listed on the Enclosure Testing Matrix, needs to take place after the installation of the first system. Moreover, at least one test needs to be performed, per system, prior to completing 10% of the installation, also at least two tests need to be performed prior to completing 30% and 50% of each systems installation.
- C. The third party testing firm hired by the Contractor shall test the buildings to the performance level as identified in the testing matrix.
 - 1. Envelope and Room Leakage test
 - a. ASTM E779- Testing procedure should include:
 - 1) One to two days of preparation and testing by a team of individuals, per floor.
 - 2) On the first evening before the actual test, Infra-red scanning will be performed under pressurized and depressurized building modes. It is preferable that the building be unoccupied during the preparation and test (possibly a weekend), since some exits may be blocked, and mechanical ventilation systems shut down.
 - 3) The team will start by meeting with building owner, contractor, and commissioning staff to review the building and building drawings, and beginning to prepare the floor. Preparations should include wedging open all interior doors in open position in order to equalize the pressure on the exterior enclosure (pressure boundary) of the building; closing exterior doors, windows and mechanical system vents and openings; and assuming control over the status of mechanical systems. Sealing all opening to other floors (confirm items to be sealed with CxA). The air leakage testing will be done with large blowers and fans, temporarily installed in exit stair doors or exterior doors, to pressurize or depressurize the building. The test procedures will be based on Enclosure Testing Matrix.
 - 2. ASTM C1060, and E1186 –Test 100% of the Building Envelope: Insulation at wall and roof plus air barrier. Provide thermo-graphic building survey (thermal imaging) of completed wall and roofing systems following,
 - a. Survey to evaluate locations, consistency, and relative state of dryness of insulation, missing insulation, and potential leak sources for water and air, if any. Furnish report of survey which includes photographs, data, and analysis of each area of survey. Verify minimum temperature differential required (normally 40 degrees F). Intervals as follows:
 - 1) Exterior Walls: Prior to Substantial Completion and after building enclosure with exterior walls completed and permanent HVAC system operating.
 - 2) Testing requires a delta of 15°F between interior and exterior for optimum infrared scanning results.
 - 3) Roof: Within 2 months of completion of roof including after building enclosure with exterior walls completed.
- D. Acceptance criteria will be in accordance with the manufactures, AAMA, ASTM or specified allowances.
 - 1. Test pressures for the Wall Assemblies as identified in the testing matrix.
 - 2. Failure of On-Going Building Enclosure Field Testing
 - a. Upon failure of a test during on-going building enclosure testing, the sample rate increases from the initial sample rate to two and one-half (2½) times the initial sample rate. Therefore, if the initial sample rate is 2%, the new sample rate would be 5%. The new

sample rate would continue until three (3) subsequent tests groups pass, and then would revert to the initial sample rate. Upon a failure of a test at the increased sample rate, the sample rate increases to three (3) times the increased sample rate.

- b. The new sample rate would continue until three (3) subsequent test groups pass, and then would revert to the previous sample rate.
- c. Each additional failure would increase the sample rate three (3) times the previous sample rate, up to a 100% sample rate. Each new sample rate would continue until three (3) subsequent test groups pass, and then would revert to the previous sample rate.
- d. In the event of any conflict between the other Contract Documents and the foregoing minimum criteria, the more stringent shall govern.
- e. All costs associated with increased sample rates will be the responsibility of construction manager. These increased costs will include increased Commission Agent's costs.

3.10. TEST REPORTS

- A. Provide copies of all reports required per set forth in the referenced test procedure, for review.
 - 1. Provide the information listed below in addition to the requirement in item 1.
 - a. Report the following information for ASTM E 783:
 - 1) Testing agency, requester of test, date and time of test, date of report, identification, and location of building.
 - 2) Test specimen description.
 - 3) Detailed drawings of the specimen (if available).
 - 4) Sampling procedures.
 - 5) Test parameters.
 - 6) Ambient test conditions.
 - 7) Pressure differences and Leakage.
 - b. Report the following information for ASTM E1105:
 - 1) Testing agency, requester of test, date and time of test, date of report, identification, and location of building.
 - 2) Test specimen description.
 - 3) Detailed drawings of the specimen (if available).
 - c. Sampling procedures.
 - 1) Test parameters.
 - 2) Test conditions.
 - 3) Test results.
 - 4) Compliance statement.
 - d. Report the following information for ASTM 779: (Envelope Air Tightness Test)
 - 1) Building description, including location, address (street, city, state or province, zip or postal code, country, and elevation [above mean sea level in m (ft.)].
 - 2) Construction, including date built (estimate if unknown), floor areas for conditioned space, attic, basement, and crawl space, and volumes (optional) for conditioned spaces, attic, basement, and crawl space.
 - 3) Condition of openings in building envelope including:
 - 4) Doors, closed, locked or unlocked;
 - 5) Windows, closed, latched or unlatched;
 - 6) Ventilation openings, dampers closed or open;
 - 7) Chimneys, dampers closed or open
 - 8) Statement whether the test zone is interconnected with at least door-sized openings. If not, the results of pressure measurements between portions of the zone.
 - 9) Procedure, including the test equipment used (manufacturer, model, serial number), and calibration records of all measuring equipment.

- 10) Measurement data, including:
 - 11) Fan pressurization measurements (inside-outside zero flow building pressure differences);
 - 12) Inside and outside temperature (at start and end of test) and the product of the absolute value of the indoor/outdoor air temperature difference multiplied by the building height;
 - 13) Time, building pressure difference, air density, nominal airflow rate, fan airflow rate, and air leakage rate;
 - 14) Deviations from standard procedure.
 - 15) Optional data, including wind speed/direction and whether wind speed is estimated to exceed 0 to 2 m/s (0 to 4 mph).
- e. Calculations, including:
- 1) The leakage coefficient and pressure exponent for both pressurization and depressurization;
 - 2) The effective leakage area. Also, report if a reference pressure other than 4 Pa is used; and,
 - 3) An estimate of the confidence limits.
- f. Report the following information for ASTM ASTM C 1193
- 1) Record test conditions and results for each procedure on an appropriate form.
 - 2) Each joint is unique, and as such requires that the procedures described in this method be subjectively applied and/or modified for each test.
 - 3) Retain the sealant samples in a sealed plastic bag, labeled with the location from which sample was taken, date removed, results from the method and project identification. These samples should be stored in a secure location for the duration of the warranty period.
 - 4) Accurate recording of the location, description of the sealant anomalies as they are observed is important.
 - 5) There is no one single procedure that is most appropriate for all projects, therefore an effective method needs to be selected for each project.
 - 6) Use of the shop (submittal) and/or architectural drawing, to notate pertinent data has proven reliable on some projects.
 - 7) When the inspection is complete, a photograph of the joint and associated masking tape can be of value. It is important that the photograph be of good quality so that the markings can be clearly read. This is true for both destructive and non-destructive test.

3.13 BUILDING ENVELOPE TESTING MATRIX

A. Envelope Testing Matrix as follows;

Building Envelope Testing Matrix								
System	Field Checklists	Performance Testing	Referenced Test Standard	Sampling Rate	Test Date	Required	Results	Remarks
Division 7 - Thermal and Moisture Protection								
Fluid-Applied Air Barrier	Yes	Yes	ASTM E 779, ASTM C 1060	Test whole building under pressurization and depressurization at six data points each. Perform thermographic survey concurrent with pressurization or depressurization testing		(example: 0.25 cfm/sf at 75Pa)		
Division 8 - Openings								
Aluminum-Framed Entrances and Storefronts	No	Yes	AAMA 501.2	Test three units, minimum.		(example: no water penetration)		

END OF SECTION 019118