

SECTION 084430
UNITIZED CURTAINWALL SYSTEMS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:

- A. LEED REQUIREMENTS: This specification section has USGBC LEED® point ramifications. Contractor(s) shall execute all work in full compliance to LEED® requirements associated with this and related specification sections. LEED requirements have been included as a part of the general and special requirements of this specification and apply to this and all other sections of the specification. Where discrepancies exist between specification references, the most stringent shall apply.
- B. Drawings and general provisions of the Contract, including General and Supplementary Conditions and DIVISION 01 Specification Sections, apply to this Section.

1.02 SUMMARY:

- A. Coordinate the interface of the aluminum framing systems with other trades as necessary to provide for proper function of the combined exterior wall system components.
- B. The Unitized Curtainwall (UCW) Contractor shall provide all labor, materials, and equipment necessary to provide a complete curtain wall and window wall systems, including, but not limited to, the following:
 - 1. All glazed aluminum unitized curtain wall and/or window wall with integral components listed below, reinforcements (as required to accommodate loads shown in RWDI wind tunnel study, or other)) and aluminum trim, aluminum panels, closures and copings as required to enclose the building.
 - 2. Storefronts.
 - 3. High-performance aluminum terrace doors with medium width stiles and rails and stainless steel hardware.
 - 4. High performance 0-sight line operable ventilators, awning style, as shown on the Architect's drawings.
 - 5. Sound insulation in "stack joint" to prevent lateral sound transfer.
 - 6. Condensation diverter / collection system that drains to the exterior.
 - 7. All glazed aluminum curtain wall and/or window wall with reinforcements (if required) and aluminum trim and closures as required to enclose the buildings.
 - 8. All glass and glazing for the above components. Refer to Exterior Glass and Glazing specification for requirements.
 - 9. All curtain wall metal panels for above components including but not limited to;
 - 10. All aluminum curtain wall panels within the curtain wall.
 - 11. All sealants, caulking, joint fillers and gaskets in conjunction with the above components for weather-tight performance in the fabrication and erection of the curtain wall systems. Refer to Joint Sealers specification.
 - 12. All anchorage of above components, including pre-set inserts in concrete slab, bracing to or bracing of structural steel, kickers, reinforcing, etc. as required.
 - 13. UCW Contractor shall be responsible for bracing structure when wall kickers induce rotation into structural members.
 - 14. Provide all necessary and required design and engineering labor for the complete and total design of the curtainwall systems.

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15. Provide all exterior curtainwall system materials and labor for visual and performance mock-ups as shown in the architectural documents. The curtainwall contractor shall be responsible for the interface of the exterior wall systems, including the coordination of all trades, including inside drywall, if necessary.
16. Field testing of installed work.
17. All necessary steel or aluminum reinforcement members.
18. All vents, weeps, weep tubes, bellows, baffles, closures, end dams, gutters, flashings, trim as shown or as may be required in conjunction with system or to join systems to adjacent construction.
19. A UL rated fire safing and smoke seal at slab edges, including support system. Refer to Firesafing specification.
20. All exterior wall insulation and air/vapor barrier required on above items.
21. Patching of sprayed on fire proofing at kickers, anchor, or bracing attachments.
22. Coordination with storefronts for Integral swing doors, revolving doors, all-glass doors and entrance vestibules including hardware, security equipment and coordination of locations for electrical supply in the system.
23. Protection and cleaning.
24. All engineering calculations and shop drawings of the system, including anchorages.
25. Drawing shall be presented so other contractors can coordinate their work.
26. Seals of all electrical penetrations.

C. Related Sections:

1. Division 03 Concrete
2. Section 07 2100 Façade Insulation and Safing
3. Section 07 9100 facade Sealants
4. Section 08 8100 Exterior Glass and Glazing

1.03 REFERENCES:

- A. The work of this section shall comply with the latest edition of the following. When conflicts arise between references, the more stringent shall apply. The curtain wall design shall accommodate and incorporate any miscellaneous devices or work as required by the standards.
- B. Aluminum Association:
 1. Specifications for Aluminum Structures.
 2. Aluminum Design Manual.
- C. American Architectural Manufacturers Association:
 1. AAMA CW-1, Aluminum Curtain Wall Design Guide Manual.
 2. AAMA TIR-A9, Metal Curtainwall Fasteners”
 3. AAMA 501, Methods of Test for Exterior Walls.
 4. AAMA 501.1, Standard Test Method for Water Penetration of Windows, Curtainwalls and Doors Using Dynamic Pressure.
 5. AAMA 501.2, Quality Assurance and Diagnostic Water Leakage Field Check of Installed Storefronts, Curtain Walls and Sloped Glazing Systems.

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6. AAMA 501.4, Recommended Static Test Method for Evaluating Curtainwall and Storefront Systems Subjected to Seismic and Wind Induced Inter-story Drifts.
 7. AAMA 502, Voluntary Specification of Field Testing of Windows and Sliding Glass Doors.
 8. AAMA 506, Voluntary Specifications for Hurricane Impact and Cycle Testing of Fenestration Products.
 9. AAMA 609 & 610, Cleaning and Maintenance Guide for Architecturally Finished Aluminum.
 10. AAMA 907, Voluntary Specification for Corrosion Resistant Coatings on Carbon Steel Components.
 11. AAMA 910, Voluntary "Life Cycle" Specifications and Test Methods for Architectural Grade Windows and Sliding Glass Doors.
 12. AAMA 1503, Voluntary Test Method for Thermal Transmittance and Condensation Resistance of Windows, Doors and Glazed Wall Sections.
 13. AAMA 1801, Voluntary Specification for the Acoustical Rating of Windows, Doors and Glazed Wall Sections.
 14. AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
- D. American Iron and Steel Institute:
1. Specifications for the Design of Cold-Formed Steel Structural Members.
- E. American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI):
1. ASCE/SEI-7, Minimum Design Loads for Buildings and Other Structures
- F. American Society of Heating, Refrigerating and Air-Conditioning Engineers, Latest Version:
1. ASHRAE Handbook Fundamentals
 2. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
- G. American Welding Society:
1. AWS D1.1/D.1.1M - Structural Welding Code – Steel.
 2. AWS D1.2/D.1.2M - Structural Welding Code - Aluminum.
- H. ASTM International (ASTM):
1. A36/A 36M-05 - Specification for Carbon Structural Steel.
 2. A123/A 123M-02 - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 3. A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessel and General Applications.
 4. A1008/A1008M, Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High- Strength Low-Alloy with Improved Formability, Solution Hardened and Bake Hardenable.
 5. A1011/A1011M, Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High- Strength Low-Alloy with Improved Formability and Ultra-High Strength.
 6. B209/B209M, Aluminum and Aluminum-Alloy Sheet and Plate (Metric).
 7. B221/B221M, Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes (Metric).
 8. B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
 9. B429/B429M, Aluminum-Alloy Extruded Structural Pipe and Tube.

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10. C509, Standard Specification for Cellular Elastomeric Performed Gasket and Sealing Materials.
 11. C864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks and Spacers.
 12. C1115, Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
 13. D2244, Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
 14. D4214, Test Methods for Evaluating Degree of Chalking of Exterior Paint Films.
 15. E84, Test Method for Surface Burning Characteristics of Building Materials.
 16. E90, Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions.
 17. E283, Standard Test Method for Rate of Air Leakage through Exterior Windows, Curtain Walls, and Doors.
 18. E330, Standard Test Method for Structural Performance of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 19. E331, Standard Test Method for Water Penetration of Exterior Windows, Curtain Walls, and Doors by Uniform Static Air Pressure Difference.
 20. E699, Criteria for Evaluation of Agencies Involved in Testing Quality Assurance and Evaluating Building Components in Accordance with Test Methods Promulgated by ASTM Committee E-6.
 21. E783, Standard Test Method for Field Measurement of Air Leakage Through Installed Exterior Windows and Doors.
 22. E987, Standard Test Methods for Deglazing Force of Fenestration Products.
 23. E1105, Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, Curtain Walls by Uniform or Cyclic Static Air Pressure Difference.
 24. E1401, Standard Guide for Structural Sealant Glazing.
 25. E1886, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Storm Shutters Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
- I. Glass Association of North America (GANA):
1. Glazing Manual
- J. International Building Code (IBC):
1. IBC-2009
- K. International Organization for Standardization/International Engineering Consortium (ISO/IEC):
1. 17025, General Requirements for the Competence of Testing and Calibration Laboratories.
- L. National Fenestration Rating Council (NFRC):
1. NFRC 100, Procedure for Determining Fenestration Product U-Factors
 2. NFRC 200, Procedure for Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
- M. Society of Automotive Engineers (SAE):
1. SAE AMS QQ-P-416, Plating, Cadmium (Electrodeposited)
- N. The Society for Protective Coatings (SSPC):
1. Paint 12, Cold-Applied Asphalt Mastic (Extra Thick Film)

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- O. Code of Federal Regulations (CFR):
 - 1. 40 CFR 59, Subpart D, National Volatile Organic Compound Emissions Standard for Architectural Coatings.
- P. 2009 IBC
- Q. Local Building Codes
 - 1. Massachusetts Building Code 8th Edition

1.04 ALLOWANCES:

- A. Provide Field Testing as a part of the testing and inspecting requirements of section 3.03 in this specification.

1.05 PERFORMANCE REQUIREMENTS:

- A. Exterior enclosure shall consist of glazed aluminum assemblies, manufactured metal panels, sealing systems and support systems. The exterior enclosure work, as installed, shall meet or exceed the herein specified minimum structural and weather resistant requirements, as demonstrated by engineering calculations and testing.
- B. Methods of fabrication and assembly (except as specified herein, or as recommended by the Architect as a consequence or result of testing), shall be at the discretion of the UCW Contractor (subject to acceptance by the Architect) provided that the exterior and interior visible architectural effect is not changed, the work of other Contractors is not affected, and the weather-tightness and strength qualities, as demonstrated by engineering calculations and measured by the results of the tests for performance requirements, are not reduced.
- C. Remedial measures, which may be necessary on the mock-ups or the building, shall maintain standards of quality and durability, and are subject to acceptance by the Architect.
- D. Provision for Thermal Movements
 - 1. The work shall be designed to provide for such expansion and contraction of component materials, as will be caused by an exterior ambient temperature ranging from 0^oF to metal surface temperature of 180^oF, without causing buckling stresses on glass, failure of glass, metal, stone or joint seals, undue stress on structural elements, damaging loads on fasteners, reduction of performance, or other detrimental effects. The amount of such movement that is accommodated in the UCW Contractor's design shall be identified on UCW Contractor's submittal drawings, and shall be accompanied by thermal calculations.
- E. Structural Properties:
 - 1. The exterior building system wall shall be designed to withstand the wind pressures to be defined by the RWDI Wind Study.
 - 2. Performance criteria at design pressures and loads for structural members supporting the exterior enclosure components shall be as follows:
 - (a) Perpendicular to the plane of the wall, net deflection of members directly supporting each type of the enclosure components shall not exceed the following values. The span "L" is defined as the distance between the centerline anchor points of the member. For cantilevers, span is defined as two times the distance between anchor centerline and end of cantilever. Where a sealant joint occurs between a framing member and a relatively stiff building element, framing member deflection shall not exceed 1/2 of the nominal joint width, or less if required by sealant manufacturer. Where a framing member runs continuously past a

deflecting support, the support deflection shall be considered in the analysis.

- 1). Metal members supporting glass shall be per AAMA TIR-A11-96 and shall not exceed $1/240 + 1/4$ " for spans of 13'-6" or greater or $1/175$ times span, or $3/4$ inch for spans less than 13'-6", whichever is less.
- 2). Metal members supporting panels shall not exceed $L/175$.
- (b) In the plane of the wall, deflection of framing members that support glass or metal panels shall not exceed $1/8$ inch. This includes horizontal rail sag due to dead load. Any twist of the horizontal sill members due to dead load shall be limited to one (1) degree.
- (c) Corner curtain wall mullion in-plane deflection due to wind pressure shall be limited to $1/4$ " maximum at any time. Reduce deflection further if required for assembly and fit of component, or performance of sealant in joints.
- (d) Anti-buckling clips shall be used as required to keep mullion halves together under load.
- (e) At connection points of framing members to anchors, combined movement of anchor relative to building structure, and framing member relative to anchor, shall not exceed $1/16$ inch in any direction.
- (f) The center deflection of the coping, an interior trim or grating, or any component that could be stepped on, when subjected to a 250 lb. vertical concentrated load, is to be a maximum of $1/8$ inch. No permanent set is allowed when load is removed.
- (g) Stresses shall not exceed the allowable values established by the specifications listed in code standards. In no case shall allowable values exceed the yield stress. Where permitted by code, a $1/3$ increase in allowable stress for wind or seismic load is generally acceptable, but not in combination with any reduction applied to combined loads.
3. Sealants and interior finishes shall not be assumed to contribute to framing member strength or stiffness.
4. At 1.5 times the design pressure loads for metal members supporting glass the net permanent deflection of framing members shall not exceed $1/1000$ times span. There shall be no failure or gross permanent distortion of framing members, anchors or connections. At connection points of framing members to anchors, combined movement of anchor relative to building structure, and framing member relative to anchor, shall not exceed $1/16$ inch set after load is removed. Gross permanent distortion is any appearance and or evidence of yielding or permanent displacement of framing members.
5. Vibration harmonics, wind whistles, noises caused by thermal movement, thermal movement transmitted to other building elements, loosening, weakening or fracturing of attachments or components of system are not permitted in the installed work.
6. Headed concrete studs welded to steel elements and cast-in-place with structural concrete shall have a minimum safety factor of 2.0 against ultimate failure. Channel-type (Halfen or Jordhal) or ferrule type

concrete inserts shall have minimum safety factor of 3.0 against ultimate failure. All drilled expansion or wedge type anchors shall have a minimum safety factor of 4.0 against ultimate failure. The use of a 1/3 increase for allowable stresses is not acceptable unless written approval by manufacturer is provided.

7. The wind directionality factor, k_d , shall be 1.0 unless the combined loading effects as defined by ASCE7 are used. Components and cladding loads should be taken from the RWDI report.
8. Seismic Design:
 - (a) Provide strength, stiffness and movement capabilities as required by governing code for seismic design, ASCE7, IBC and local code. The amount of such movement that is accommodated in the Contractor's design shall be identified on the Contractor's submittal Drawings, and shall be accompanied by seismic calculations.
 - 1). Seismic Use Group = I
 - 2). Seismic Design Category = B
 - 3). Seismic Importance Factor = 1.0
 - 4). SDS = .303
 - 5). SD1 = .109
 - (b) Story Drift:
 - 1). Curtain wall shall meet design seismic displacement and 1.5 times design displacement when tested in accordance with AAMA 501.4.
 - 2). The wall system shall be designed to accommodate the seismic drift requirements as defined by ASCE7, IBC and local code. The interpretations of the minimum design requirements are as follows:
 - 3). The elastic inter-story drift displacement (ΔS) shall be not less than 0.005 times the story height.
 - 4). At this drift level the wall shall not experience any failure in materials, sealants, anchorage of any kind and shall be fully functional both air and water tight as well as structural.
 - 5). The design inelastic inter-story drift requirement (ΔM) shall be based on the results of the building frame analysis by the project structural engineer or 0.02 times the story height, whichever is greater.
 - 6). At this level of displacement the wall may experience localized material failures, sealants may tear and framing elements may warp and buckle. However, no anchor shall fail nor shall any portion of the wall systems experience catastrophic failure by falling from the building.
- (2) Provision for Movement of the Structure:
 - (a) The work shall be designed to accommodate dead load and +/- 1/2" live load deflection (ONLY AFTER CURTAINWALL IS INSTALLED), thermal expansion, elastic shortening, concrete or steel creep and/or sway and torsion of the building, as may be anticipated. To this end, Contractor shall obtain all necessary projected data and make such provision in the work as may be necessary. The amount of such

movement that is accommodated in the Contractor's design shall be identified on Contractor's submittal Drawings.

- (b) Allow for $L/500 \ 1/2"$, whichever is greater, upward and downward live load at the mid-point of each bay or the end of each cantilever, for floor slab deflection.

F. Air Infiltration:

- (a) Air leakage through the barrier system behind the enclosure shall not exceed 0.06 cfm/ft^2 of fixed wall area or when tested accordance with ASTM E-283 at a test pressure of 6.24 PSF.

G. Water Penetration:

- (a) Water penetration, in this specification, is defined as the appearance of uncontrolled water on the indoor face of any part of the work. "Controlled" water or condensation is that which is demonstrably drained harmlessly to the exterior of the work without endangering or wetting adjacent surfaces or insulation, and not visible in the final construction.
- (b) Provision shall be made to drain to the exterior face of the work, any water entering at joints, and/or any condensation occurring within the work. The wall shall be designed to collect and remove all secondary water from the surrounding conditions. At insulated areas, gutter shall extend to the inside vertical plane of the insulation.
- (c) No uncontrolled water penetration shall occur when the work is tested in accordance with ASTM E-331 at a pressure differential of 15 PSF.
- (d) No uncontrolled water penetration shall occur when the work is tested in the field per AAMA 501.3 with a pressure differential of 15 PSF.
- (e) No uncontrolled water penetration shall occur when the work is tested in accordance with AAMA 501.1 using a dynamic pressure equal to 15 PSF.
- (f) For terrace doors, use pressure differentials of 12 psf.

H. Condensation Resistance Requirements:

- (a) It is intended to prevent excessive condensation on the indoor face of the work or internalized within the wall system in any manner that will cause degradation of any wall system component, with the heating and ventilating system in operation and under the following conditions. Fabricate, assemble and erect the work to achieve and maintain this design intention.
- (b) Winter Outdoor: Ambient temperature 6° F ; 7.5 mph wind.
- (c) Winter Indoor: Ambient temperature of 70° F ; Relative Humidity of 30%.
- (d) Excessive condensation is defined as water, ice or frost on more than 5% of the interior or internal surface of any module or component of the wall or the accumulation of uncontrolled flow of water from condensation or melted frost on the wall at any location. An interior or internal surface of any module is any surface other than an exterior surface.

I. Thermal Requirements:

- (a) The exterior wall system framing and glazing areas shall provide an average Thermal Transmittance U-Value of 0.40 BTU/hr/ft²/degF as determined according to NFRC 100.
- (b) The exterior wall system framing and glazing areas shall have a Solar Heat Gain Coefficient no greater than 0.38 as determined according to NFRC 200.

J. Acoustical Requirements:

- (a) Provide unitized curtain wall systems with glass, other substrate infills and framing areas having the following sound transmission characteristics:
 - 1). Typical zone from levels ?? to ??;
 - (a) Outdoor Indoor Transmission Class: Minimum 34 when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.
 - 2). Acoustically enhanced zone from levels ?? to ??;
 - (a) Outdoor Indoor Transmission Class: Minimum ?? when tested for laboratory sound transmission loss in accordance with ASTM E90 and determined by ASTM E1332.

K. Variations in Structure: (will be per AISC code of Standard Practice and spec section 051200)

- (a) Permissible non-accumulative up/down, in/out and/or left/right dimensional tolerances in the building frame and other work adjacent to the wall are as follows:
 - 1). Plumb variations such as faces of exterior columns and walls are 1/4 inch in 10 feet, 1 inch maximum for total height of structure.
 - 2). Variations from levels shown on drawings, top and bottom surfaces of beams shall be plus or minus 3/4" inch.
 - 3). Variation from location shown on drawings, outer faces of walls and framing members shall be plus or minus 1 inch.
 - 4). Variation from location shown on drawings for adjacent surfaces of spandrel materials or jamb materials is a maximum of 1/4 inch.

L. Glass Strength

- 1. Glass thicknesses when shown on Drawings are for convenience of detailing only and are to be confirmed by UCW Contractor and/or glass manufacturer. Provide glass for size openings indicated in thicknesses such that probability of breakage at "Design Wind Pressure" will not exceed 8 lights per 1000 lights (SF 2.5) for vertically glazed lites and 1 lite per 1000 for slope glazed lites. Provide substantiating glass breakage data in the form of calculations by the glass manufacturer.

1.06 VISUAL MOCK UPS

- A. Visual mockups will be shown on the Architect's drawings
 - 1. A composite mockup of the main curtain wall and window wall, with terrace door and operable ventilator.
- B. Visual mockups will be constructed from the same glass and metal finishes as specified herein and will be constructed and designed to allow for substitution of glass and metal finishes.

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- C. It is understood that some exterior profiles are possibly custom extrusions and that the visual mockup will replicate these shapes as closely as possible.
- D. A drawing submittal is required to show the exact profiles intended for use showing the proposed profiles.
- E. Mock-up shall accurately represent job conditions including joints, sealants, glass, glazing, anchors and finishes per mock-up drawing.
- F. The visual mockup shall be used to demonstrate the proposed range of aesthetic effects and workmanship.
- G. This visual mockup is to be scheduled and performed prior to any material procurement for the project.

1.07 LABORATORY MOCK-UPS AND TESTING

- A. The UCW Contractor to furnish, build and test a mock-up containing the glazed curtain wall and window wall, including terrace doors and operable ventilators. Scope of mock-up will be shown on architectural drawings. The UCW Contractor shall be responsible for scheduling and coordination of mock-up at an independent testing facility. Mock-up shall accurately represent job conditions including joints, sealants, glass, glazing, anchors, insulation and finishes per mock-up drawing. Delay installation of thermal insulation until completion of initial air, water and structural tests.
- B. Provide at least one extra light of glass for each type and size on the mock-up. Glass that breaks during testing shall be replaced with new glass and the test continued. Repeated glass breakage at design pressures shall constitute failure.
- C. Prepare and submit complete mock-up drawings and structural calculations stamped by a licensed professional engineer acceptable to the AHJ. Construct mock-ups in strict accordance with approved mock-up shop drawings. Any deviation from or additions to details shown on drawings are subject to approval from Architect. Do not use excessive amounts of sealant, nor other special measures or techniques, which are not representative of those to be used on the building.
- D. Tests specified below shall be performed on the mock-up and paid for by the UCW Contractor. Any additional or retesting costs, including any costs or expenses incurred by the Contractor, Architect or their Consultants, shall be paid for by the UCW Contractor.
- E. Tests shall be conducted at an independent testing laboratory, as approved by the Architect and Owner. The testing laboratory shall be responsible for conducting and reporting the tests, shall state in the report whether or not the test specimen conforms to all requirements of the contract documents, and shall specifically note any deviations there-from. Construction Research Laboratory in Miami, FL USA and Architectural Testing, Inc in York, PA USA are acceptable for mock-up tests. Other laboratories or test facilities may be acceptable and are subject to approval. Submit detailed information on facilities and test equipment for alternate test sites upon request. Manufacturer's laboratories are not acceptable test facilities.
- F. The testing laboratory shall not act as consultant to a contractor for this project, modify contract document requirements, modify mock-up configuration, or dismantle mock-ups until notified that no further testing is required. At the direction of the Architect, deliver completely disassembled mock-up or selected portions of the mock-up, boxed or crated to the job site, to the exterior wall contractor's facility, or dispose of mock-up properly. No mock-up stone shall be reused on the job.
- G. Mock-ups are subject to observation by the Owner, Contractor, Architect and their Consultants throughout their fabrication, assembly, erection and testing. Provide minimum three weeks notice before beginning manufacturer and construction of mock-up. Provide materials and personnel for prompt continuous construction of mock-ups. Delays in mock-up construction due to lack of materials or personnel could result in the UCW Contractor being charged for

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- fees and travel expenses of observers. UCW Contractor shall coordinate chamber availability, shipping schedules and mock-up construction schedules directly with the laboratory.
- H. If failures occur, revise and retest mock-up. Modifications must be realistic in terms of job conditions, must maintain standards of quality and durability, and are subject to approval by Architect.
 - I. In general, performance requirements specified for test mock-ups and samples also apply to the actual building, and vice versa. Variations in criteria over the surface of the building, such as wind pressure, are taken into account in testing of mock-ups and samples. Where certain performance is required for specific test conditions of mock-ups and samples, that same performance is also required of the actual building, for natural conditions equivalent to or less severe than the test conditions.
 - J. Construction Contractor shall submit laboratory's proposed test procedure for Architects approval four weeks prior to erection. Erection at testing laboratory shall not commence prior to review of laboratory's proposed test procedure by Architect.
 - K. Laboratory test report must be accompanied by "as built" mock-up drawing showing any revisions or corrective measures taken during testing. Any modifications on mock-up must be done on job unless Architect specifically approves otherwise. Mock-up must be supervised by and installed by same workman that will do actual job.
 - L. Prior to mock-up installation or fabrication, provide to sealant manufacturer samples of all relevant substrates, including finished aluminum, coated glass, gaskets, stone, backers and any other substrates which will require sealant contact. Samples shall be labeled and identified for this project. Sealant manufacturer shall perform tests to verify adhesion, staining and chemical compatibility. Use sealants and substrates only in combinations for which favorable adhesion and compatibility results have been obtained. Submit for record sealant manufacturer's written test reports, and recommendations regarding cleaning and priming required to obtain acceptable adhesion.
 - M. Mock-up test specimen shall be tested in the following order:
 - 1. Preload specimen at 50% of inward (positive) design pressure and open/close operable elements 5 times.
 - 2. Air leakage per ASTM A283 using a pressure of 6.24 PSF (50 mph wind). Test and measure both infiltration and exfiltration. Air leakage not to exceed 0.06 cfm/ft² of projected gross wall area. Air leakage of individual components also shall not exceed 0.06 cfm/ft² of component. Verify air flow thru each component of the specimen.
 - 3. Static water penetration per ASTM E331 using a pressure of 15 PSF. No uncontrolled water penetration allowed.
 - 4. Dynamic water penetration per AAMA 501.1 using a pressure of 15 PSF. No uncontrolled water penetration allowed.
 - 5. Structural performance per ASTM E330 using negative and positive pressures as in the RWDI report. Deflections shall be measured and recorded. Unitized curtainwall system shall not open-up and require temporary sealing to accomplish negative pressure test. If the wall can not hold negative pressure at design loads then that constitutes a failure.
 - 6. Repeat test #2.
 - 7. Repeat test #3.
 - 8. Repeat test #4.
 - 9. Three cycles, in each direction, lateral/side-sway/seismic movement. Move intermediate floor level left and right for three cycles. Movement shall be equal to design or 25mm (1") up and 25mm (1") down. No yielding, no breakage, no tearing, no disengagement allowed. Materials

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shall return to original at rest position at conclusion of each cycle. Intermediate floor of the mock-up shall be returned to the nominal position and will remain in that position for the duration of the mock-up testing.

10. Repeat test #2.
11. Repeat test #3.
12. Repeat test #4.
13. Three cycles, in each direction, inter-story differential movement. Move intermediate floor level up and down for three cycles. Movement shall be equal to design or 25mm (1") up and 25mm (1") down. No yielding, no breakage, no tearing, no disengagement allowed. Materials shall return to original at rest position at conclusion of each cycle. Intermediate floor of the mock-up shall be jacked so that the wall system stack joint is moved to the anticipated fully open position and will remain in that position for the duration of the mock-up testing.
14. Repeat test #2.
15. Repeat test #3.
16. Repeat test #4.
17. Perform a thermal cycle/condensation resistance test by enclosing the lower 30 ft. high portion of the main elevation of the specimen with an additional insulated test chamber equipped with refrigeration for cooling and heat lamps for heating. The specimen shall be monitored using thermocouples located at suitable areas to determine the performance of the wall and test conditions. The interior design conditions are 70° F, 20% relative humidity. Any measured surface which falls below this dew point temperature shall be considered non-compliance with the performance criteria. The specimen shall be subjected to 3 temperature cycles with each cycle consisting of the following conditions.
 - a. 0° F +/-5° exterior air temperature until equilibrium.
 - b. 180° F +/-5° maximum wall temperature until equilibrium.
18. If any portion of the wall design or any component of the exterior facade incorporates a structural poured and de-bridged thermal break or other structural thermal break method, the specimen shall be tested to design loads per ASTM E330 during the last cold cycle and during the last warm cycle of the thermal cycle/condensation resistance test. This structural test shall be performed when the specimen is at equilibrium. Visual inspection and deflection readings using dial indicators shall be taken during these tests.
19. Repeat test #2.
20. Repeat test #3.
21. Repeat test #4.
22. Structural overload test per ASTM E330 using 1.5 times the design load pressure. Deflections shall be measured and recorded. No permanent set of more than L/1000 is allowed. No permanent set in anchors of more than 1/16" is allowed. Unitized curtainwall system shall not open-up and require temporary sealing to accomplish negative pressure test. If the wall can not hold negative pressure at 1.5 design loads then that constitutes a failure.
23. Repeat both lateral/side-sway/seismic and inter-story horizontal movement tests as described above, three cycles, both left/right, and

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in/out to seismic overload movement criteria. Minor damage is allowed. Structural stability of wall components shall remain in tact. Sealants may tear and metal yielding is allowed.

24. Where the test sequence or test failures requires successive water infiltration tests, the only means used to drain water from internal cavities shall be gravity drainage through the weep system for a minimum of 15 minutes. Air pressure, removal of parts, or other means of draining water shall not be used.

1.08 SUBMITTALS:

- A. Comply with the requirements of Section 01 33 00 Submittals and with the specific requirements listed below.
- B. LEED Submittal:
 1. Product data for Credit EQ 4.1: For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
- C. Submit with bid, proposal scope drawings for all typical areas of the building including its relationship to adjacent construction. Quality and content of scope drawings shall be the same as required for building drawings, except that non-typical conditions need not be included.
- D. Prior to submitting any documents required for approval, provide an itemized list of specification requirements and architectural drawing requirements which are not embodied in the contract, or intended contract, for work of this section. Identify the specification page and paragraph, or the architectural drawing sheet, elevation, plan, section or detail for each item. Deviations not specifically identified in this manner shall not be deemed valid in submittal review, and shall be cause for disapproval at the reviewers' discretion. In the event that there are no deviations, provide a written statement of full compliance with architectural drawings and specifications. Failure to provide an itemized list of deviations in the required form or a statement of full compliance shall, at the reviewer's discretion, be cause for return of any and all submittals for approval without review, with the contractor bearing full responsibility for any resultant delay.
- E. With first submittal of structural calculations for approval, provide dimensioned die drawings for all structural aluminum extrusions. In the event that extrusion profiles are not finalized, provide die drawings for the profiles contemplated at that time. If profiles are revised, provide revised die drawings with the first calculation or shop drawing submittal which follows the revision. Die drawings shall show all profile dimensions, metal thickness, alloy and temper.
- F. Prior to building construction, provide glass manufacturers wind/thermal stress analysis, and center deflection calculations showing that specified maximum probabilities of breakage are not exceeded.
- G. Prior to building construction, provide sealant manufacturer's test reports confirming adhesion of all sealants to all relevant substrates. Provide samples of production materials to sealant manufacturer for adhesion tests. Adhesion shall be evaluated, and is required to be acceptable, after initial cure and after water immersion for seven days. Evaluate adhesion of immersed samples immediately after removal from water. Provide stain test reports on the natural stone, cast stone and pre-cast concrete. Provide written certification from the sealant manufacturer that sealant selected is compatible with all adjacent materials and finishes. Provide written shop drawing review and comment from sealant manufacturer.
- H. Prior to building construction, provide glass manufacturer's written statement that any insulated, heat treated, reflective, spandrel or laminated glass is suitable for such application. Submit letter stating manufacturer has reviewed the unitized curtainwall shop drawings and has approved the glazing details shown therein.

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- I. Provide the following submittals for acceptance. First submittals and re-submittals shall be complete and in the required form. Re-submittals shall include requested corrections and shall respond to previous comments. Each sheet that is revised shall bear a revision date and number. Revisions shall be flagged with a conspicuous revision symbol and number and revised detail clouded. Failure of a submittal to be complete, in the proper form, responsive to comments or identify revisions shall, at the reviewers' discretion, be cause for disapproval and return of documents without review, with the UCW Contractor bearing full responsibility for any resultant delay. Failure to review comments or to note a noncompliance with plans and specifications shall not relieve the UCW Contractor from his obligation to comply. Failure to review comments or to note a noncompliance on a given submittal shall not preclude a directive to comply on future submittals. Allow sufficient time for preparation and processing of submittals and re-submittals to avoid conflicts with schedules.
- J. Provide shop drawings showing materials in place on the building including coordination of related and adjoining work; embed layout/cast-in-place insert drawings and erection diagrams. Show relative layout for all adjacent walls, beams, columns slabs, ceilings, etc. Drawings shall include elevations, floor plans, sections and full size details. Details shall be full size and fully drawn, not outlined. Provide isometric details of any conditions, as requested by the Architect. Typically, required isometric details are the curtain wall 3-way intersections where a parapet condition intersects a 90 degree curtain wall corner and all such complex intersecting walls to show how the continuity of rain screens, air seal and vapor barrier are accomplished. Drawings shall include the following information:
 1. Joinery and internal weather seals.
 2. Show details of adjacent construction and how the unitized curtainwall system provides continuity of air and water seal lines/planes.
 3. Glass and metal thicknesses, including tolerances.
 4. Metal alloy, temper and finish.
 5. Glass manufacturer strength, thickness, tint, coating, opacifier or ceramic frit, safety backing, and rating of insulated units.
 6. Fastener manufacturer, material alloy, plating, diameter, length, spacing, embedment and edge distances. Provide a table of fasteners including full size head and side view.
 7. Glazing materials identification. Provide a table of glazing infills, gaskets and spacers including the manufacturer, manufacturer's part number, make-up/material composition, color, and profile of each profile where applicable. Also include any plastic or elastomeric parts that are used within the metal framing system.
 8. Sealants identification by product name and manufacturer, including cleaning and priming requirements. Provide a table of sealants including manufacturer, type and color with reference to specific surface preparation instructions.
 9. Relative layout of walls, beams, columns and slabs with dimensions noted. Indicate all dimension tolerances that are required or indicate what tolerances can be accommodated.
 10. Field connections, weld sizes, anchorages, and fasteners, embedment length and edge distances.
 11. Dimensioned position of glass edge relative to metal daylight opening.
 12. Glass or other infill edge bite and structural silicone sealant bond width and depth dimensions.
 13. Glazing and re-glazing procedures for all infills.

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14. Dimension limits of movements for all moving joints and provisions for building and system movements. Indicate values for each component of expansion and contraction movements and include a sum. Indicate where the unitized curtainwall system accommodates these movements in all directions.
 15. Spotting plans or layout drawings for preset embeds/inserts in structure or in adjacent construction.
 16. Perimeter sealant joint sizes, including tolerances and minimum/maximum joint sizes required.
 17. Seal and signature of professional engineer currently registered by the Authority Having Jurisdiction (AHJ) for the location where the work will be installed. The AHJ for this project is the State of Massachusetts. This shall be same engineer who signs the calculations.
- K. Provide structural calculations, sealed by a licensed professional engineer currently registered by the AHJ. Calculations shall be prepared in compliance with referenced documents and these specifications. Where specifications and code differ, the more severe requirements shall govern. Test reports are not an acceptable substitute for calculations. Calculations shall include the following information:
1. Analysis for all applicable loads on framing members, terrace doors and operable ventilators.
 2. Analysis for all applicable loads on anchors, including anchors embedded in concrete.
 3. Section property computations for framing members.
 4. Analysis of system accommodation for building movements.
 5. Thermal modeling of all vertical and horizontal curtain wall section details. Lawrence Berkeley Laboratory version 5+ Therm and Window software shall be used to provide modeling and computation of the U-Value and to identify extreme temperature limits of the exterior and interior surfaces of the wall system components. Models shall include the perimeter conditions of this project where practical. Include isotherm and color infrared diagrams of each profile section. Report shall include color prints of isotherm and color infrared details.
- L. Seal and signature of professional engineer currently registered by the AHJ on drawings and calculations.
- M. Submit samples of all materials to be encompassed in the work in the size and quantity as required by the project documents. These will include but not be limited to, samples of:
1. Extrusions, flat sheet, or formed shapes showing finish. Show any variations in color or texture, if any, by providing range samples.
 2. Architect reserves right to require submittal of fabrication samples, showing prime members, joinery, anchorage, expansion provisions, glazing, sealant details and similar details, profiles and intersections.
 3. Glass samples, 300 mm (12 inches) square, of all types specified.
 4. Stone samples, 300 mm (12 inches) square, of all types specified, including stone anchors manufactured by others to be used and integrated with the system.
 5. Tech data on all proposed sealants, along with color chart, and cured samples.
 6. 300 mm x 300 mm (12 inch X 12 inch) samples of insulation with tech data.
 7. 300 mm (12 inch) length of fire safing with tech data.

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8. All extrusion die drawings and 300 mm (12 inch) long samples of the production run on all extrusion shapes involving a snap fit. Snap fits are to be designed using 1/2 standard tolerances.
 9. Glass setting blocks, side spacers, gaskets and shims.
 10. Samples of gaskets, rods, tapes, glazing accessories. Gasket test reports, sealant test reports, and technical data on all glazing accessories.
 11. Shim materials for structural and non-structural connections.
 12. Submit manufacturer's product data and specifications for any materials, or fabrication techniques used in the unitized curtainwall work. Include instructions/recommendations for installation and maintenance. Include certified test reports showing compliance with requirements where test methods are indicated. Test reports must be less than 5 years old.
- N. Maintenance Manuals: Include all pertinent documents for the maintenance and continuous performance of the unitized curtain wall system. Provide "As-Built" shop drawings, extrusion die drawings, piece and part drawings, unit assembly drawings, shop installation instructions, field installation instructions, sealant installation instructions, cleaning procedures, re-glazing procedures, stone replacement procedures and schedule of recommended maintenance.
- O. Warranty: Sample of special warranty.
- 1.09 QUALITY ASSURANCE:
- A. Installer (UCW Contractor) Qualifications: Engage a single firm to assume undivided responsibility for fabrication and installation and total coordination of all components of the curtainwall work. This firm must demonstrate not less than 5 years successful experience in fabrication and installation of work similar to the work of this project. The work of this section shall be performed by the UCW Contractor, who is regularly engaged in the engineering, fabrication, finishing and installation, of similar work.
 - B. Manufacturer Qualifications: Manufacturer of unitized curtainwall system and components shall be capable of producing unitized curtainwall systems to meet the performance requirements of these specifications. Manufacturer's technical representatives shall make quarterly site visits to provide documented Quality Assurance of the Installers work.
 - C. The Sub-Contracting of any work included hereunder is specifically prohibited, except for that which may be accepted by the Architect in writing 10 days prior to award of the contract.
 - D. The Owner and the Architect reserve the right to visit the fabricating and manufacturing facilities of the approved UCW Contractor, any approved sub-contractor or material supplier at any time when the work is in progress. All shop and field materials and workmanship shall be subject to inspection by the Architect or his representatives at all times. Such inspections do not relieve the UCW Contractor from obligations to provide the curtain wall system conforming to all requirements of the Contract Documents. Coordinate compatibility and design integrity to secure a weather and water tight seal with all systems, adjacent surfaces and related materials.
 1. Do not revise the aesthetic effects, as judged by the Architect and/or Owner, except with the Architect and/or Owner's approval. If revisions are proposed, submit comprehensive explanatory data to Architect and/or Owner for review and determination.
 - E. Testing Agency Qualifications: Qualified according to ASTM E699 for testing indicated.
 - F. Energy Qualifications: Comply with NFRC for minimum standards of energy performance, materials, components, accessories and fabrication. Comply with more stringent requirements, if indicated.
 - G. Welding Qualifications: Qualify procedures and personnel according to the following:

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1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

1.10 DRAWINGS AND SPECIFICATIONS

- A. The character of these documents is intended to provide a performance type specification for the design, fabrication and installation of the aluminum curtain wall systems. UCW Contractor is responsible for the engineering and design of all components and materials as well as the fabrication, installation and performance of the curtain wall systems.
- B. Architectural drawings are diagrammatic. The architectural details shown are intended as a guide for the aesthetic and interfacing requirements of the various components of the exterior wall to and with other work. The requirements shown by the details are intended to establish basic dimensions of the module and the sight lines, jointing and profiles of members. The UCW Contractor is responsible for the design and engineering of the system within these aesthetic parameters. The drawings are not to be construed as engineering design, or adequate to meet the engineering design requirements.
- C. It is recognized that the architectural design details do not cover some conditions or modifications, which may be required. It is, however, intended that conditions not detailed shall be developed through the UCW Contractor's shop drawings to the same level of aesthetics and in compliance with performance criteria as indicated for detailed areas and as stipulated in these specifications. The UCW Contractor, by accepting a contract for the work, acknowledges this and agrees that the Architect shall have the final say as to all matters whether detailed or not on the architectural design details.
- D. The UCW shall coordinate with all structural and architectural drawings.

1.11 DELIVERY, STORAGE, AND HANDLING:

- A. Deliver, store and handle all wall system assemblies so as to prevent damages at all times, as per manufacturer's recommendations.
- B. All materials delivered to the site shall be stored in spaces provided as coordinated with the General Contractor and/of the Construction Manager. These spaces shall be located where the stored materials will not be exposed to wetting or damage, and shall permit easy access to the handling of the materials. Materials shall be stored neatly, properly stacked, and protected.
- C. Deliver other materials, except bulk materials, to project site in manufacturer's unopened containers with name, brand, type, grade and color fully indicated thereon. Store bulk materials as required to avoid any deleterious effects of weather, soiling or contamination.

1.12 PROJECT CONDITIONS:

- A. Coordinate as required, and be totally responsible for, the full and satisfactory compatibility and performance between all sealants used under this section and those sealants used by other trades that may be in direct contact with or adjacent to sealants in this work.
- B. Take all required steps and precautions to properly isolate and prevent any degree of incompatibility between said sealants, all in strict accordance with manufacturer's specifications, recommendations and instructions.
- C. Periodically test sealants in place for adhesion, using methods recommended by sealant manufacturer. Promptly replace any sealant which does not adhere or fails to cure.

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- D. Prior to commencement of work, conduct a pre-installation meeting with the Architect and their consultants, Construction Manager, and any other relative representatives to review the installation of the work, materials selection, joint tolerances, storage, weather conditions under which work can be installed, cleaning of gutters, protection of work, insulation and fire-safing installation and the sealant techniques required. Examine a sample installation of the wall which has been prepared and determine and record whether everyone present is in agreement that the proposed installation is of the highest level of quality workmanship and is likely to perform as required. Accepted control section shall be standard to which other work must confirm.
- E. Field Measurements: Due to the lead time for unitized curtainwall system production, the UCW Contractor shall coordinate requirements for installation with the Contractors who will be placing embedments and providing structure that is necessary for uninterrupted installation of the building enclosure. It is understood that this work is beyond the reasonable control of the UCW Contractor; however the UCW Contractor shall make observations of the work installed by others prior to installation of units. The UCW Contractor shall advise the Construction Manager in a timely manner, of any discrepancies in the work that would affect the installation and cause delays.

1.13 WARRANTY:

- A. Comply with the requirements of Closeout Submittals and with the requirements herein.
- B. Before substantial completion, the UCW Contractor shall submit 2 copies of written warranty, signed by both the manufacturer and UCW Contractor agreeing to repair or replace defective materials and workmanship of the curtain wall work and damaged adjacent work during the warranty period. The UCW Contractor shall guarantee to the Owner that all work is in accordance with drawings and specifications, as amended by any changes thereto authorized by the Architect and that all work is free from defects in materials and workmanship and will remain weather-tight for a period of five (5) years from the date of acceptance of the work by the Owner. UCW Contractor shall agree to repair or replace defective materials and workmanship to "like new condition," including such exploratory work, as necessary to determine the cause, during the guarantee period, at no additional cost to the Owner. UCW Contractor shall include with bid proposed copy of proposed warranty.
- C. Defective materials and workmanship is hereby defined to include, but not be limited to, evidence of:
 - 1. Penetration of water into the building.
 - 2. Air infiltration exceeding specified limits.
 - 3. Structural failure of components resulting from forces within specified limits.
 - 4. De-lamination of laminated panels, curtain wall metal panels, glass or failure of insulated glass units.
 - 5. Cracking, crazing, flaking, of coatings or opacifiers on glass.
 - 6. Discoloration or fading, excessive non-uniformity, pitting, cracking, peeling, or crazing or corrosion of finish.
 - 7. Glass breakage.
 - 8. Secondary glass damage and/or damage due to falling curtain wall components.
 - 9. Adhesive or cohesive failure of sealant.
 - 10. Crazing on surface of non-structural sealant.
 - 11. Non-structural sealant hardening beyond Shore "A" durometer of 50 or softening below a Shore "A" durometer of 20.

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12. Failure to fulfill other specified performance requirements.
 13. Failure of operating parts to function normally.
 14. The terms used in conjunction with Finish Guarantee are defined as follows:
 - a. "Discoloration or fading": means a change in appearance which is perceptible and objectionable as determined by the Architect when viewed visually in comparison with the original color range standards.
 - b. "Deterioration" includes but is not limited to the following:
 - (1) Color fading more than 5 Hunter units when tested in accordance with ASTM D2244.
 - (2) Chalking in excess of a No. 8 rating when tested in accordance to ASTM D4214.
 - (3) Cracking, checking, peeling or failure of paint to adhere to bare metal.
 - c. "Excessive non-uniformity": means non-uniform fading during the period of the guarantee to the extent that adjacent parts have a color difference greater than the original acceptable color range.
 - d. "Pitting, cracking, peeling, crazing or corrosion": means there shall be no pitting, surface cracks, blistering, bubbles, or non-uniform surface texture or other type of corrosion discernible from a distance of three (3) meters [ten (10) feet], resulting from the elements in the atmosphere at the project site.
 - e. Finish Warranty Period: 20 Years from the date of Substantial Completion to make good, including materials and labor.
 15. The sealants shall carry a twenty (20) year warranty from the sealant manufacturer for both material and labor to make good against adhesive or cohesive failure and staining. Warranty shall be in a form acceptable to the Owner. UCW Contractor shall include with his bid proposed copy of proposed warranty. An acceptable version would be Dow's VIP warranty.
 16. UCW Contractor shall be responsible for damage to the building and furnishings occasioned by defective materials or workmanship or damage as part of repairs to the wall.
 17. The guarantee, the enforcement or lack of enforcement thereof, shall not deprive the Owner of other actions, rights or remedies available to him. Guarantee shall be in form approved by the Owner. Repairs or replacements during the warranty period required by acts of god (which exceed performance requirements), alterations, abuse of the work, vandalism, failure of the supporting structure and other causes beyond the UCW Contractor's control, will be completed by the UCW Contractor and paid for by the Owner at the prevailing rates. This warranty and its enforcement shall not deprive the Owner of other action right or remedy available to him.
- 1.14 MAINTENANCE SERVICE:
- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of loading dock equipment Installer. Include quarterly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper loading dock equipment operation at rated speed and capacity. Provide parts and supplies the same as those used in the manufacture and installation of original equipment.

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- B. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.01 MANUFACTURERS:

- A. Sota Glazing
- B. Permasteelisa
- C. Others many obtain preapproval to participate in advance of bid.

2.02 MATERIALS:

- A. Provide aluminum shapes and thicknesses as shown and as required to fulfill performance requirements. Use suitable alloy for extruding with adequate structural characteristics, and suitable for finishing as specified. Comply with the following:
 - 1. ASTM B209/B209M for sheet (alloy 5052 recommended) and plate,
 - 2. ASTM B221/B221M for extrusions,
 - 3. ASTM B308/B308M for structural profiles
 - 4. ASTM B429/B429M for structural pipe and tube,
 - 5. AWS A5.10/A5.10M for welding rods and bare electrodes.
- B. Carbon steel for anchorage and/or reinforcements shall be of shapes and thicknesses required to meet structural requirements for their use. Comply with the following:
 - 1. ASTM A36/A36M for structural shapes, plates and bars,
 - 2. ASTM-A501/A501M for structural tubes,
 - 3. ASTM A1008/A1008M for cold-rolled sheet and strip
 - 4. ASTM A1011/A1011M for hot-rolled sheet and strip
 - 5. Finish requirements: Comply with the following for zinc-rich corrosion-resistant primer applied immediately after surface preparation and pretreatment:
 - a. SSPC-PS Guide No. 12 requirements,
 - b. FS TT-P-645, Primer, Paint, Zinc-Molybdate,
 - c. ASTM A123/A123M and/or ASTM A153/A153M for hot-dip galvanizing.
- C. Stainless steel for formed and machined structural components that require unfinished corrosion resistance. Comply with the following:
 - 1. ASTM A666/A666M for annealed or cold worked austenitic sheet, strip, plate and flat bar.

2.03 FRAMING:

- A. Framing members: Extruded or formed, standard or custom mullions in the wall plane of thickness required and reinforced as required to support the imposed loads.
 - 1. Construction: Thermally Broken
 - 2. Glazing system:
 - a. Captured and retained mechanically with gaskets on all four sides or,
 - b. SSG Structural silicone sealant retained.
 - 3. Stone support system (if required):
 - a. Integral 316/316L stainless anchors and attachment components or,
 - b. Bonded by lamination, polymeric-based adhesives and silicone sealant.
 - c. Glazing plane and infill locations as shown in the drawings.
- B. Spandrel Panel: Shadowbox spandrel system shall consist of:

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1. Spandrel glass as shown and specified.
 2. Aluminum foil backed mineral wool fire-resistive insulation retained mechanically, in an acceptable fire rated assembly.
 3. Sealed and breathable cavity with baffled vents.
 4. Condensation collection and diverter system shall drain to the exterior.
- C. Fasteners: Any exposed fasteners or fasteners in high humidity or wet areas of the wall shall be series 300 stainless steel. Finish exposed fasteners to match adjacent aluminum. Exposed fasteners may only be used if approved by the Architect. The work shall be designed to conceal all fasteners. Unexposed fasteners in dry areas shall be cadmium and colored chromate plated and shall meet Federal Specification QQ-P-416E, Type II, Class #1. (.0005 inches thick plating). All interior conditioned-space non-stainless fasteners being used in a structural application must meet the minimum requirements of SAE J429 Grade 5. Grade 8.0 or higher fasteners, high strength bolts of non U.S. origin, or high strength bolts that are zinc plated shall not be used. Mill test reports for all structural grade bolts shall be submitted to the Architect for his approval prior to installation of those bolts on the job. Self drilling fasteners shall be Dril-Flex as manufactured by Elco Industries, Inc. No substitutions accepted. Nuts used at expansion or moving connections shall be designed to provide a positive means of preventing disengagement. Staking of bolts, use of lock washers, or threads being deformed is not acceptable. Matched bolts, nuts, washers shall be used at all friction connections.
- D. Embeds shall be designed and furnished by the UCW Contractor for placement in surrounding conditions per layout and placement drawings furnished by the UCW Contractor. Installation of embeds shall be by others per the layout drawings.
1. Finish shall be hot dipped galvanized.
 2. Field welds must be cleaned and finished with cold galvanizing paint.
 3. UCW Contractor shall provide field fixes for missing or improperly located embedments. Each field fix structural connection shall be engineered prior to installation by a PE. The UCW Contractor may not make modifications to the unitized curtainwall system without submitting an engineering analysis that pertains to each modification or case.
- E. Curtain wall Metal Panels;
1. As required to meet specified performance, minimum 1/8" thick aluminum.
 2. Alloy 5052.
 3. Half commercial flatness tolerance.
 4. Saw cut edges where edges are exposed to view.
 5. Reinforce as required to eliminate oil canning and deflections beyond the allowable.
 6. Panels shall be V-notched to provide sharp corners at all panel bends exposed to view.
- F. Terrace Doors (including all hardware such as locks, hinges, thresholds, weatherstrips, etc);
1. acceptable manufacturers and models;
 - (a) Kawneer 2000T
 - (b) Wausau
 - (c) Windor 9050
 - (d) Torrance Series 900
 - (e) Traco
- G. Operable ventilators (including all hardware such as locks, hinges, thresholds, weatherstrips, etc);
1. Kawneer 0-sightline ventilator or equivalent.

2.04 FINISHES:

- A. All exposed exterior aluminum shall receive a 3 coat spray applied fluorocarbon coating containing a minimum of 70% Kynar 500 Resin similar to PPG DuranarXL. Coating must meet the high performance requirements of AAMA 2605. Colors shall be custom colors as per the Architect's choice.
- B. All exposed interior aluminum shall receive a baked enamel finish such as Polycron or Duracron, except if in the case of structural silicone sealant, an anodized or Alodine surface must be implemented as an incorporated strip.
- C. Submit color samples to be approved by the Architect.
- D. Apply coatings uniformly to coating manufacturer's recommended thicknesses so that there are no streaks, runs, sags, absence of coatings, blisters, "orange-peel", or similar imperfections.
- E. Concealed members to be flash anodized, such as Alodine.
- F. It is the intention of the specification that the color variation between adjacent parts of the same finish be imperceptible to the naked eye under normal daylight conditions. To this end, the Contractor shall submit range samples defining the maximum variation of color that can be anticipated in the work. Samples shall be on lengths of extrusions not less than 12 inches and on sheet/plate/panels not less than 24 inches square. Pieces abutting or within 6 inches of each other in the construction shall not vary in color by more than 1/2 the range so as the variation to be imperceptible to the naked eye under normal daylight conditions. Parts shall be carefully inspected in the shop and graded for assembly compatibility and marked for installation location.
- G. In the construction of visual mock-ups, finish the various components to show the maximum variation that will exist in the actual building construction between adjacent and non-adjacent components.
- H. Establish and submit for approval a quality control program to assure compliance with the specified requirements. The program shall include documented procedures and processes. Contractor shall maintain complete certified inspection, testing and process records of finishing procedures. Said records shall be available to the Architect upon request. No finishing shall be performed prior to approval of this quality control program.
- I. Do not ship any material that has not been inspected, tested and marked in the prescribed manner, does not fall within the prescribed color range, or has been rejected by the Architect.

2.05 GLASS AND GLAZING:

- A. All glass at curtain wall areas shall be as shown on the contract drawings, and as specified in the Section 08 8100 Exterior Glass and Glazing of the Specifications.
- B. All glass shall be heat strengthened, tempered, or laminated as required to meet wind loads, thermal stresses, safety or building codes.
- C. Furnish to the Owner a reserve stock of glass, glazing accessories, and re-glazing accessories, equal to 1% of job requirement for each type of glass of every typical size. Sizes and exact quantities to be as selected by Architect, from list of glass sizes provided by Contractor.
- D. Setting blocks must be 80 to 90 durometer extruded silicone and a minimum of 4" long. Actual size of setting blocks to conform to the GANA Guidelines. All setting blocks shall be positively restricted from lateral movement.
- E. Side spacer blocks shall be 65 + 5 durometer extruded silicone, properly sized and profiled for intended application.
- F. Vision glass re-glazing at curtain wall to be from the exterior. Vision glass re-glazing shall be done without removal of adjacent surrounding finishes. Spandrel re-glazing shall be from the exterior.

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- G. The basis of glass manufacturers/fabricators is Viracon, Owatonna, MN. Alternates are acceptable if they satisfy the performance and aesthetic requirements.

2.06 GASKETS / WEATHER-STRIPPING:

- A. All gaskets / weather-stripping shall be silicone. All gaskets / weather-stripping / spacers shall have continuous mechanical engagement to framing members. Where weather-strips and gaskets constitute the entire perimeter of the glazing substrate, they shall be continuous with vulcanized / molded corners.
- B. Sponge gaskets / weather-stripping / spacers shall be extruded black silicone with a hardness of 40 +/- 5 durometer Shore A and conform to ASTM C-509, Option A. Sponge gaskets shall be compressed 20% to 35% in the final installed position.
- C. Dense gaskets / weather-stripping shall be extruded black silicone conforming to ASTM C-864 with a hardness of 75 +/- 5 durometer Shore A for hollow profiles and 60 +/- 5 for solid profiles.
- D. Gaskets that contact structural silicone sealant shall be black silicone conforming to ASTM C-1115 with a hardness of 65 +/- 5 durometer shore A.

2.07 SEALANT MATERIALS:

- A. All perimeter and internal sealants and backers are to be defined on shop drawings and are subject to Architect's approval.
- B. Sealant use shall be in agreement with submitted written sealant manufacturer recommendations.
- C. All exterior sealants shall be silicone and meet applicable Federal Specification. Provide colors as selected by the Architect.
- D. All internal sealants used to seal glass pockets, end dams and gutters shall be silicone installed per manufacturer's recommendation. Splice details shall be designed using silicone sheet and silicone sealants. Splice details to be designed to accommodate the anticipated movement of the joint. All internal sealants which contact the perimeter sealants must be compatible with, and adhere to, the perimeter sealant.
- E. All structural silicone sealants and application thereof shall comply with ASTM E1401.
- F. Backer rod materials shall be closed cell non-gassing polyethylene foam such as "Cceva Rod" or skinned reticulated closed cell non-gassing extruded polyolefin foam rod such as "SOF-Rod" or other products recommended by the sealant manufacturer and approved by the architect.

2.08 MISCELLANEOUS MATERIALS:

- A. Provide aluminum and/or steel brackets, clips, shims and reinforcements as required.
- B. Provide stainless steel sleeve spacers and/or suitable bearing pads, as required, to insure free movement between surfaces where expansion and deflection movements are intended. Provide "Eel Slip" or "Nylatron" washers and pads of sizes and thicknesses (1/16 inch) except 1/8 inch for Eel Slip") to permanently prevent "freeze up" of joints.
- C. Flashing required within the system shall be aluminum or 316 stainless steel of acceptable design.
- D. Flashing required to join the system to adjacent construction shall be 316 stainless steel and of acceptable design and color. Submit sample to Architect for approval.
- E. Provide PVC-coated open cell reticulated urethane foam baffles at all weep holes or vent tubes. Size, length and porosity to meet water and air infiltration design requirements.
- F. Fire safing at the slab edges shall be foil backed mineral wool safing, or equal. A minimum of 4 inches thick and maximum 8 inches wide and supported in place by galvanized impaling clips at a maximum of 24 inches centers. Design of system shall be the responsibility of the Curtain Wall Contractor. Apply "approved" Smoke Seal Compound at fire safing from concrete slab edge to back of insulation. Smoke seal shall completely cover the fire safing.

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- G. Static shims shall be aluminum or high-impact polystyrene materials capable of resisting compressive and prying loads with no displacement. Steel materials may be used only if dissimilar metals separators are included. The structural engineer shall review the adequacy of shim types, materials and bearing surfaces to be provided by the installer. This shim review and analysis shall be included in the structural calculations. U-shaped shims shall have restricted throats that prevent falling-out from the fastener at each application. Shim stack thickness shall not exceed the "two times the fastener diameter" rule. Plastic storefront shims are not acceptable. Use graduated thickness shims with the largest number of the thickest shims to achieve the total required shim stack height.

2.09 OPERABLE COMPONENTS:

- A. Provide terrace doors as shown in the architectural drawings to comply with the performance requirements in this specification.
 - 1. thermally broken construction required.
 - 2. ADA compliant
 - 3. Acceptable manufacturers;
 - (a) Torrance Aluminum
 - (b) Windoor Inc.
 - (c) Wausau
 - (d) Traco
 - (e) Kawneer
- B. Provide operable ventilators as shown in the architectural drawings to comply with the performance requirements in this specification.
 - 1. 0-sight line is required.
 - 2. insect screens are required.
 - 3. highest durability hardware is required for all hardware.
 - 4. acceptable manufacturers are;
 - (a) Kawneer
 - (b) Wausau
 - (c) Efco

2.10 FABRICATION:

- A. All parts of the wall shall be of the materials, design, sizes and thicknesses shown or called for on the drawings and/or herein specified. Methods of fabrication and assembly however, unless otherwise specifically stated, shall be at the discretion of the manufacturer subject to acceptance by the Architect.
- B. Fabricate components of the system at factory, ready for field installation. Make all cutouts for penetrations at the factory, wherever possible.
- C. Fabricate components and assemble units to comply with fire and/or performance requirements specified. When assembled, the components shall have the following characteristics:
 - 1. Profiles shall have sharp edges, be straight and free of defects or deformations.
 - 2. Joints shall align accurately whether the ends are straight-cut, coped or mitered.
 - 3. Glazing shall be physical and thermally isolated from framing members.
 - 4. System shall have accommodations for thermal and mechanical movements of glazing and framing and yet maintain required edge clearances.

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5. Provisions for safety railings shall be mounted between mullions at the interior.
 6. Components shall be curved to the proper radii.
- D. Each lite of glass or other infill shall be compartmentalized with an internal guttering system that drains any water that passes joints, condensation that occurs within the framing system and/or components and moisture that migrates from within the curtainwall system to the exterior.
 - E. Provide a means to prevent the intrusion of sand and dust that may collect on the wall, settle and cake from blocking or deterring any weep drain or pressure equalized venting system that is necessary for the system to meet performance requirements.
 - F. Changes of plane, parallel or transverse to longitudinal axis shall be accomplished as detailed on the drawings, in the factory wherever practical and with a minimum of field fabrication.
 - G. All fitting and assembly work shall be done in the shop.
 - H. Exposed fasteners on finished surfaces will not be permitted.
 - I. Protection against galvanic action shall be provided wherever dissimilar metals are in contact, except in the case of aluminum in contact with galvanized steel, zinc or relatively small areas of stainless steel or nickel silver (white bronze). This protection shall be provided by painting the dissimilar metal surfaces with a heavy coat of zinc-rich primer or by application of an appropriate sealant or tape or other approved galvanic isolator. Minimum thickness of dissimilar metals separation shall be 0.76 mm (30 mil).
 - J. Aluminum which is to be in contact with cured concrete, mortar or plaster shall have the contact surfaces protected. This shall be accomplished by the use of a heavy coat of bituminous paint applied to the aluminum, or other permanent separator on concealed contact surfaces of the aluminum before assembly or installation.
 - K. Items of carbon steel, unless galvanized or scheduled for other finish, shall be thoroughly cleaned of all loose scale, filings, dirt and other foreign matter and shall be painted with zinc chromate primer, complying with Specification FS TT-P-645 and SSPC-SP12.01. Surface preparation shall meet the minimum requirements of SSPC-SP6.
 - L. All welding shall be in accord with pertinent recommendations of the American Welding Society and shall be done with electrodes and/or by methods recommended by the suppliers of the metals being welded. Type, size and spacing of welds shall be as shown on approved shop drawings and structural calculations. Paint all field welds with zinc rich primer.
 - M. Welds behind finished surfaces shall be done as to minimize distortion and/or discoloration on the finished side. Weld splatter and welding oxides on finished surfaces shall be removed by de-scaling and/or grinding. Telegraphing of welds through a finished surface will not be accepted.

PART 3 - EXECUTION

3.01 EXAMINATION:

- A. All work shall be performed by skilled workmen, especially trained and experienced in this type of work. If the UCW Contractor chooses to sub-contract the installation of work, the proposed sub-contractors qualifications shall be approved by the Architect and Construction Manager.
- B. Bench marks for elevation and building line offset marks for alignment shall be established on each floor level by the Construction Manager, who shall be responsible for their accuracy. Should any error be found in their location, the UCW Contractor shall so notify the Construction Manager in writing, and installation work shall not proceed in the affected area until the errors are corrected.
 1. After lines and grades have been established, and before beginning installation in any area, the UCW Contractor shall examine all parts of

the structure on which the wall is to be placed in that area. Should any conditions be found which, in his opinion will prevent the proper execution of his work, he shall report such condition in writing to the Architect and the Construction Manager. Installation work shall not proceed in that area until such conditions are corrected or adjusted to the satisfaction of the Architect and the UCW Contractor. Commencement of work shall constitute acceptance of surrounding conditions.

3.02 INSTALLATION:

- A. Embeds shall be designed and furnished by the UCW Contractor for placement, in surrounding conditions per layout and placement drawings furnished by the UCW Contractor. Design to be based on concrete slab strength as specified in other Specification Sections.
- B. Install exterior wall components plumb, level, accurately aligned and accurately located in reference to column lines and floor levels. Adjust work to conform to the following tolerances (maximum variations).
 - 1. Permissible dimensional tolerances in the building frame and other work adjacent to the wall are as follows:
 - (a) Plumb variations such as faces of exterior column and walls are 1 inch in 100 feet.
 - (b) Variation from levels shown on drawings such as top and bottom surfaces of floor slabs and spandrel beams shall be plus or minus 1 inch.
 - (c) Variation from location shown on drawings such as outer faces of walls, framing members and floor slabs shall be plus or minus 1 inch.
 - 2. The wall system shall be designed to accommodate above tolerances. Provided irregularities do not exceed them, and clearances shown on approved shop drawings are maintained, all parts of the metal curtain wall, when completed, shall be within the following tolerances:
 - (a) Maximum variation from plane or location shown on approved shop drawings: +/-1/8" per 12 foot length or 1/4" in any total length.
 - (b) Maximum offset from true alignment between two identical members abutting end to end in line: -0, +1/32" (Example: horizontal attachment to a vertical).
 - (c) Maximum offset from true alignment where surfaces meet at corners: -0, +1/8" (Example: horizontal attachment to a vertical).
 - (d) Maximum offset from true alignment between two identical members abutting end in line and are engaged by a metal to metal mechanical connection: -0, +1/32" (Example: hairline joint between a sill and a stool trim).
 - (e) Limit difference between diagonal measurements to +/-1/8 inch (Example: squareness of a glazed opening measured diagonally).
 - 3. Anchorage of the wall to the structure shall be by approved methods in strict accordance with accepted shop and/or erection drawings. Supporting brackets shall be so designed as to provide three-dimensional adjustment and accurate location. Once wall is properly positioned, all connections so designated on accepted shop drawings shall be rigidly fixed by welding or other positive mechanical means.
 - (a) In reinforced concrete construction, reinforcing shall be located 1.5" from face of slab and 0.75" from top or bottom of slab.

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4. Expansion anchorage shall be so designated to provide for thermal and building movements. Anchorage design shall provide for unrestricted movement. Molybdenum-disulfide filled nylon ("Nylatron") slip pads and washers shall be used at all thermal or dynamic bolted-connection-type anchors.
- C. All exposed work shall be carefully matched to produce continuity of line and design with all joints, unless otherwise shown or specified being accurately fitted and rigidly secured. Exposed edges shall be finished to match face of the work.
- D. All welding shall be done by skilled mechanics qualified or licensed in accord with local building regulations, and shall conform to the recommended practices of the American Welding Society. Special care shall be taken to protect glass, natural stone, insulation and other finished surfaces from damage and to prevent causing fires. All welds must be prepared and touched up with two (2) coats of zinc rich primer.
- E. Any weld splatter on glass or exposed surfaces will be cause for rejection of glass or other exposed material. Glass with weld splatter will be replaced at no cost to the Owner.
- F. Sealing materials specified shall be used in strict accordance with the manufacturer's printed instructions, and shall be applied only by mechanics especially trained or experienced in their use. Before applying sealant, all mortar, dirt, dust, moisture and other foreign matter shall be completely removed from surfaces it will contact. Adjoining surfaces shall be masked when required to maintain a clean and neat appearance. Sealing compounds shall be tooled to fill the joint and provide a smooth finished surface.
- G. Back seals and bridge seals at gutters and between natural stone panels and metal panel system to aluminum framing system shall be installed as necessary.
- H. Install all internal condensation gutters, including end dams and end seals.

3.03 FIELD TESTING

- A. Testing of installed portions of the curtain wall and adjacent surrounds shall be tested in accordance with AAMA 503. A minimum of two (2) tests shall be performed. The architect and consultants shall determine the location and size of the test area. Other conditions for field testing shall be as stipulated below.
 1. The size of the curtain wall test specimen shall be a minimum of 3 bays wide by two floors high and include the horizontal stack joint, terrace doors and operable ventilators. The test chamber shall be constructed to allow observation of the specimen from inside the chamber.
 2. The testing of the air infiltration shall be at 6.24 PSF and the fixed glazing areas of the façade shall meet or exceed 0.06 CFM / FT². The 50% increase of the air infiltration specified in ASTM E783 shall not be allowed.
 3. The testing of the water penetration shall be performed at a pressure differential of 15PSF. The reduction in test pressure differential specified in ASTM E1105 shall not be allowed.
 4. The interior line of sealant at the curtain wall test area shall not be installed for testing.
 5. The interior finishes shall not be installed at the test area.
 6. The CW Contractor and Construction Manager shall schedule work as necessary, such as out of sequence sealant work, so that the wall can be tested as specified.
 7. Remove and replace components where test results indicate they do not comply with the specified requirements.

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- B. Curtain wall shall receive a minimum of three water hose tests in field during construction. Area and time of tests shall be per the direction of the Architect. Tests to be conducted per AAMA 501.2. Water penetration is as defined previously herein. UCW Contractor to provide powered scaffold, hose, water supply, communication system and manpower to perform tests. Test wall at 20%, 50% and 80% completion. Schedule any work necessary, such as out of sequence sealant work, so that wall can be tested as specified.
- C. Depending upon the prevalence or absence of leakage in initial water penetration test, and upon measures adopted by UCW Contractor to eliminate source of leakage, Architect will determine necessity for, and scope of additional tests, methods and procedures. Remedial measures shall maintain standards of quality and durability and are subject to approval. In no case, will total of tested area amount to less than 1.0%, nor more than 10.0%, of the exterior wall area except as subsequently authorized by the Owner.
- D. All cost of additional tests, including fees and costs incurred by the Owner, Architect and their Consultants shall be paid for by the UCW Contractor.

3.04 POSTPONEMENT OF COMPLETE ENCLOSURE

- A. If so directed by the Construction Manager, installation of the exterior wall shall be postponed in specific locations so as to facilitate moving material into and out of the building during construction.

3.05 PROTECTION AND CLEANING

- A. The UCW Contractor shall remove from the installed work all mastic smears or other unsightly marks caused by his workmen, and shall be responsible for any damage to or disfigurement of the work caused at any time by other trades, as well as final cleaning and washing of glass and aluminum. The UCW Contractor shall advise the Contractor of proper and adequate protection and cleaning procedures during remainder of construction period so that system will be without damage and deterioration at time of acceptance.
- B. Clean debris and excess fireproofing debris from behind curtain wall and exterior wall system secondary gutters during erection. Provide temporary closures to prevent accumulation.

3.06 ACCEPTANCE

- A. Installed materials which are damaged, or which in the opinion of the Architect do not conform to the specification requirements, shall be removed and replaced with acceptable material at no additional cost to the Owner.
- B. Demonstrate proper cleaning methods and materials to Owner's maintenance personnel.
- C. Provide "As-Built" shop drawings and maintenance manuals per requirements of the project documents.
- D. Prior to installation of any insulation, the secondary gutter system shall be inspected for cleanliness. The insulation shall not be installed until the Architect or the Owner's representative accepts the condition of the gutter system.