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**PART 1 GENERAL****1.1 RELATED DOCUMENTS**

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

**1.2 SUMMARY**

- A. This Section includes conventionally glazed aluminum curtain walls installed as unitized assemblies.
- B. Related Sections:
1. Division 1 Section "Sustainable Design Requirements".
  2. Division 7 Section "Building Insulation" for insulation materials installed with glazed aluminum curtain wall systems.
  3. Division 7 Section "Fire-Resistive Joint Systems" for perimeter fire containment systems installed with glazed aluminum curtain wall system.
  4. Division 7 Section "Joint Sealants" for installation of joint sealants installed with glazed aluminum curtain walls and for sealants to the extent not specified in this Section.
  5. Division 8 Section "Glazing" for glass requirements.
  6. Division 8 Section "Fixed Louvers" for units installed with glazed aluminum curtain walls.
- C. Extent of Work: Details for the glazed aluminum curtain wall are shown schematically and together with the profiles to be developed are intended to establish performance, profiles and material qualities desired.
1. The glazed aluminum curtain wall as shown shall be a complete system including all stiffeners, fasteners, sealants, drainage systems, gasket, joining, miscellaneous pieces, and material thicknesses as required to form a high quality weatherproof enclosure with two distinct lines of protection for air and water infiltration in accordance with the profiles shown.
    - a. Pressure equalize system at its interior plane of the glazing.
      - 1) Exterior rain barrier not tightly sealed but capable of protecting openings to the exterior.
      - 2) Backup air space to equalize to exterior air pressure.
      - 3) Airtight and watertight structural barrier to the interior.
      - 4) Second line of weathertight sealant to the interior inside of thermal barrier system shall have the same capacity as exterior barrier.
    2. Details not shown are similar in character to those detailed.
    3. The Contractor shall be responsible for development of final details to accommodate the fabrication, erection, and installation of the work in accordance with the design intent shown.
    4. All proposed details and finishes for each type of glazed aluminum curtain wall system shall be reviewed and accepted by the Architect prior to fabrication.
- D. Design Drawings: The Architect's drawings indicate the design concept, the visual overall size, profile, intent and location of various glazed aluminum curtain wall components and relation to adjacent construction, and together with specified "Performance Requirements", tolerances, materials, finishes and glazed aluminum curtain wall standards, impose the requirements to be conformed to by the Contractor's proposed glazed aluminum curtain wall system.
- E. Design Modifications: Drawings include visual size of profile and relation to adjacent construction and are not indicative of a known system.
1. Make design modifications of work shown only as may be necessary to meet performance requirements and coordinate the work, subject to the Architect's acceptance.
  2. Variations in details and materials which do not adversely affect appearance, durability or strength shall be submitted to the Architect for review.
  3. Maintain the general glazed aluminum curtain wall design concept without altering profiles and alignments shown.

**1.3 DEFINITIONS**

- A. Permanent Deformation: Deflection without recovery exceeding 1/1000 of span.
- B. Water Penetration: Appearance of uncontrolled water, other than condensation, on inboard surface of glazed aluminum curtain wall.

- C. Uncontrolled Water: Presence of water appearing on interior metal surfaces through caulked joints or at glazing or other gaskets that may flow to the building interior.
  - 1. Water contained within gutters, channels or other devices inboard of the air seal leading to weepage is permitted.
- D. Excessive Condensation: Visible water, ice or frost on more than 5% of the area of any module of the glazed aluminum curtain wall, or the accumulation of uncontrolled condensation flowing from the glazed aluminum curtain wall at any location.
- E. Excessive Fading: Change in appearance which is perceptible and objectionable to Architect when viewed visually in comparison with original acceptable color range.
- F. Excessive Non-Uniformity of Color or Shade: Non-uniform fading during warranty period to extent that adjacent panels have color difference greater than original acceptable color range.
- G. Cracking, Peeling, Pitting or Corroding: Defects discernible from a distance of 10', resulting from natural elements.
- H. Color Fade: Not to exceed 5 E units (National Bureau of Standards) calculated in accordance with ASTM D2244 on exposed surfaces cleaned with clean water and soft cloth.
- I. Chalking: Not exceeding rating No. 8 on exposed unwashed surfaces.
- J. Stack Joint: Junction of one unit to another at a continuous horizontal datum.
- K. Unitized: Custom shop fabricated aluminum assembly width and height as shown, with continuous gutter and 2 distinct lines of air and water protection utilizing pressure equalization chamber.

#### 1.4 QUALITY ASSURANCE

- A. The work of this section shall be performed by a company which specializes in the type of glazed aluminum curtain walls work required for this Project, with a minimum of 10 years of documented successful experience and shall be performed by skilled workmen thoroughly experienced in the necessary crafts.
  - 1. Work shall be performed in compliance with Owner's insurance underwriters' requirements and UL approvals and testing for materials, assemblies and procedures.
- B. Manufacturer shall specialize in manufacturing the type of glazed aluminum curtain walls specified in this section, with a minimum of 10 years of documented successful experience, and have the facilities capable of meeting all requirements of Contract Documents as a single-source responsibility and warranty.
- C. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- D. Preconstruction Testing Agency Qualifications: Qualified according to ISO/IEC 17025 and accredited by ICC-ES for preconstruction testing indicated.
- E. Plant/Project Site Documentation:
  - 1. Quality control procedures in the plant and at Project site shall be documented in writing and submitted to Architect and Owner for review.
  - 2. Documentation shall include schedules, details, isometric or explanatory sketches clearly and adequately cross-referenced to shop drawings to ensure fabrication and installation of curtain wall system are in accordance with Contract Documents and certified for structural compliance by an engineer registered in the State of California.
- F. Plant Inspection:
  - 1. At Architect's and Owner's option, arrange free access to curtain wall manufacturing plant for observation of manufacturing, glazing and finishing process.

- G. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction.
1. Do not revise intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If revisions are proposed, submit comprehensive explanatory data to Architect for review.
- H. Welding Qualifications: Qualify procedures and personnel according to the following:
1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."
- I. Energy Performance Standards: Comply with NFRC for minimum standards of energy performance, materials, components, accessories, and fabrication. Comply with more stringent requirements if indicated.
1. Provide NFRC-certified glazed aluminum curtain walls with an attached label.
- J. Performance Mockups: Build mockups to demonstrate aesthetic effects and set quality and performance standards for fabrication and installation.
1. Build mockup of typical wall area as shown on Drawings and according to requirements in Part 4 "Mock-up Panel Construction".
  2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
- K. Preinstallation Conference: Conduct conference at Project site.
- L. Visual Mock-ups: Prior to installing glazed aluminum curtain wall system, construct mock-ups for each form of construction and finish required to verify selections made under Sample submittals and to demonstrate aesthetic effects as well as qualities of materials and execution.
1. Build mockup of typical wall area as shown on drawings.
  2. Build mock-ups using materials indicated for completed Work.
  3. Notify Architect 7 days in advance of the dates and times when mock-ups will be constructed.
  4. Demonstrate the proposed range of aesthetic effects and workmanship.
  5. Obtain Architect's approval of mock-ups before start of Work.
  6. Retain and maintain mock-ups during construction in an undisturbed condition as a standard for judging the completed Work.
    - a. When directed, demolish and remove mock-ups from Project site.
- M. Manufacturer's identification tags or marks are not acceptable on surfaces which will remain exposed to view after installation.
1. Evidence of "patching" after removal of tags or marks is not acceptable.

## 1.5 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by preconstruction testing of glazed aluminum curtain walls representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Glazed aluminum curtain walls shall withstand movements of supporting structure including, but not limited to, story drift, twist, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads.
    - a. Curtain wall system shall be designed for axial, flexural, shear and torsional stresses and any combination thereof due to wind, thermal and gravity loads.
    - b. "Allowable stresses" for aluminum curtain wall elements shall not exceed minimum standards published in the Aluminum Association's Aluminum Construction Manual "Specifications for Aluminum Structures", Latest Edition, and other applicable codes and regulations.
    - c. Coordinate with design requirements for this Project.
  2. Failure also includes the following:
    - a. Thermal stresses transferring to building structure.
    - b. Glass breakage.
    - c. Noise or vibration created by wind and thermal and structural movements.
    - d. Loosening or weakening of fasteners, attachments, and other components.
    - e. Failure of operating units.
    - f. Deflection exceeding specified limits.

- g. Framing members transferring stresses, including those caused by thermal and structural movements, to glazing.
  - h. Sealant failure.
  - i. Air infiltration and water penetration exceeding specified limits.
  - j. Condensation exceeding specified limits.
3. Story Drift: Provide glazed aluminum curtain-wall systems that accommodate design displacement of adjacent stories indicated.
- a. Design Displacement: As indicated on Structural drawings. Shall accommodate the building dynamics, and the following, including the tolerances of related work. The following deflections shall be taken concurrently:
    - 1) Live Load Vertical Floor Deflection: 0" up at all locations, and 1/2" down at all locations, additive to any accommodation for erection and fabrication.
    - 2) Building Lateral Deflection: Not less than 3/4" in all directions, as measured between equivalent points on typical adjacent floors.
    - 3) Axial Lengthening and Shortening of Building Columns: 1/4" per floor due to building deflection.
    - 4) Connections shall permit movement in the plane of the panel for "story drift" and shall be properly designed sliding connections using slotted or oversized holes or may be connections which will permit movement by bending of steel or other connections providing equivalent sliding and ductility capacity.
  - 4. Dimensional tolerances of building frame and other adjacent construction.
  - 5. Codes and regulations of other governing agencies applicable to curtain wall system shall apply to work of this section.
    - a. When applicable Codes or specified requirements differ, the more stringent conditions which provide the most unfavorable conditions shall govern.
    - b. Code Compliance: City of San Francisco, California.
- B. Delegated Design: Design glazed aluminum curtain walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Structural Loads:
- 1. Wind Loads:
    - a. Wind loads on curtain wall system shall be referred to as the "Design Wind Pressure" in this section.
    - b. Design Wind Pressure: Shall be in accordance with building code specified in this section and wind tunnel tests.
    - c. Wind pressures act perpendicular to flat surfaces, regardless of the surface orientation for wind pressures acting on corners and other changes in plane.
      - 1) Both surfaces shall be assumed to experience their inward and outward design pressures simultaneously.
      - 2) Design for simultaneous occurrence of inward design pressure on one surface, and outward design pressure on the adjoining surface, is not required.
    - d. Performance criteria at "Design Wind Pressure" for metal members supporting glass and panels shall be as follows:
      - 1) Perpendicular to the plane of the wall, net deflection of framing members shall not exceed L/175 of clear span, or 3/4", whichever is less for spans up to 13'-6" and L/240 + 0.250" for spans greater than 13'-6" per AAMA TIR-A11.
        - a) Span is defined as the distance between anchor centerlines.
        - b) For cantilevers, span is defined as the distance between anchor centerline and end of cantilever.
        - c) Where a sealant joint occurs between a framing member and a stiff building element, framing member deflection shall not exceed 1/2 of the normal joint width, or less if required by sealant manufacturer.
        - d) Where a framing member runs continuously past a deflecting support, the support deflection shall be added to the member deflections.
      - 2) In the plane of the wall, deflection of framing members shall not reduce the glass or panel bite below 75% of the design dimension, and shall not reduce the glass or panel edge clearance below 25% of the design dimension or 1/8", whichever is greater.
        - a) Restrict deflection further, if required, for assembly and fit of components.
      - 3) At the connection points of framing members to anchors, combined movement of anchor relative to building structure, and framing member relative to anchor, shall not exceed 1/8" in any direction.

- 4) Stresses shall not exceed the allowable values established by the specifications listed under "Reference Standards".
  - a) In no case shall allowable values exceed the yield stress.
  - b) 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.
  - c) An increase in allowable working stress is not permitted for thin metal legs bent about the weak axis or for welds.
- 5) Glass, sealants and interior finishes shall not be assumed to contribute to framing member strength, stiffness or lateral stability.
- 6) Compression flanges of flexural members may be assumed to receive effective lateral bracing only from anchors to the building structure, and horizontal glazing rails or interior trim, which are in contact with the compression flange.
  - a) Points of contraflexure shall not be regarded as lateral braces or as the end points of an unbraced length; unbraced length shall be the actual distance between effective lateral braces as defined above.
- 7) Where a framing member reaction is resisted by a continuous element, the maximum assumed effective length of the resisting element shall be four (4) times the bearing length, but not more than one foot.
- e. Performance criteria at 1.5 times "Design Wind Pressure" for metal members supporting glass and panels shall be as follows:
  - 1) Net permanent deflection of framing members shall not exceed 1/1000 times span.
  - 2) There shall be no failure or gross permanent distortion of framing members, anchors or connections, or any other portion of the entire system.
  - 3) At connection points of framing members to anchors, combined movement of anchor relative to building structure, and framing member relative to building structure, and framing member relative to anchor, shall not exceed 3/16" in any direction, nor 1/8" set after load is removed.
2. Window washing scaffold/exterior maintenance system tiebacks shall be designed to carry 150 pounds acting normal to the wall inward and outward, and 150 pounds side load in each direction acting parallel to the wall.
  - a. These loads do not act simultaneously with each other, but do act simultaneously with a  $\pm 6.24$  PSF uniform load.
  - b. The tieback anchor assembly shall withstand a load of 600 pounds acting in/out or sideways without ultimate failure or glass breakage in combination with a  $\pm 6.24$  PSF uniform load.
  - c. Contractor shall verify ultimate failure load with selected window washing equipment manufacturer to insure a minimum safety factor of 4.
3. Seismic Loads: As indicated on Structural Drawings.
  - a. Seismic Testing - Phase I:
    - 1) Seismic Criteria: Design for seismic loads and seismic movements as required by Code and per structural drawings.
      - a) At any given floor, the maximum seismic displacement shall be assumed to occur while the floors immediately above and below remain in an undisplaced condition.
      - b) For seismic displacement up to and including the maximum value, there shall be no failure or gross distortion of anchors, frames, glass or panels.
      - c) Design seismic displacement shall be as determined.
      - d) Joint widths shown on the drawings are for the design profile only.
      - e) It is the responsibility of the Contractor to establish the joint width, and to verify the seismic displacement requirements.
    - 2) Testing Conditions:
      - a) Mock-up chamber shall be constructed so the simulated floor structure at approximate mid-height of the mock-up is movable, in a horizontal sense, parallel and perpendicular to the glass plane(s).
      - b) Displace movable structure first in one direction, then in the other direction.
        - (1) Time limit one (1) minute per cycle.
    - 3) Seismic Drift Movement: Based on a typical floor height 14'-9".
      - a) 0.75" outward, then return to original position.
      - b) 0.75" inward, then return to original position.
      - c) Repeat the above displacements two (2) additional times.
      - d) 0.75" to the left, then return to original position.
      - e) 0.75" to the right, then return to original position.
        - (1) No yielding or breakage is allowed.
          - (a) Record any detrimental affects after each displacement.
        - (2) No permanent deformation in excess of L/500 as allowed by AAMA.
        - (3) No ultimate failure, no breakage of surrounding materials is allowed.

- (4) No failure to meet specified water intrusion and air leakage criteria.
- b. Seismic Testing - Phase II: Conform Seismic Criteria and Testing Conditions to the same as specified above for Seismic Testing - Phase I.
    - 1) Seismic Drift Movement: Based on typical height of 14'-9".
      - a) 3.0" outward, then return to original position.
      - b) 3.0" inward, then return to original position.
      - c) Repeat the above displacements two (2) additional times.
      - d) 3.0" to the left, then return to the original position.
      - e) 3.0" to the right, then return to the original position.
      - f) Repeat the above displacements two (2) additional times.
        - (1) Record any detrimental effects after each displacement.
      - g) Sealants may tear, metal may yield, glass may crack, but no material may fall out or fall off the wall.
    - 4. Metal panel copings, ledges, setbacks, and parapet caps:
      - a. Metal panel copings, ledges, setbacks, and parapet caps shall be designed to resist the full design wind load as applied to the curtain wall in combination with a 250-pound point load.
      - b. Metal panel copings, ledges, setbacks, and parapet caps shall not permanently deform under applied load. Temporary deflection shall not harm adjacent components of the wall including aluminum and glass.
    - 5. Canopies:
      - a. Canopies shall be designed to resist the full design wind load as applied to the curtain wall in combination with a 250-pound point load.
      - b. Canopies shall not permanently deform under applied load. Temporary deflection shall not harm adjacent components of the wall including aluminum, seals and glass.
    - 6. Personnel Restraint Track: Comply with OSHA regulations and all applicable codes and regulations.
  - D. Structural-Test Performance: Test according to ASTM E330 as follows:
    - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
    - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, and permanent deformation of main framing members exceeding 0.1 percent of span.
    - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
  - E. Water Penetration Under Static Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to ASTM E331 at a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).
  - F. Water Penetration Under Dynamic Pressure: No evidence of water penetration through fixed glazing and framing areas when tested according to AAMA 501.1 at dynamic pressure equal to 20 percent of positive wind-load design pressure, but not less than 15 lbf/sq. ft. (720 Pa).
    - 1. Maximum Water Leakage: No uncontrolled water penetrating assemblies or water appearing on assemblies' normally exposed interior surfaces from sources other than condensation. Water leakage does not include water controlled by flashing and gutters outboard of the air seal that is drained to exterior.
    - 2. Provisions shall be made to drain to exterior of wall, water entering at joints or glazing reveals, any condensation occurring within the assemblies, and adjacent wall systems secondary, and similar conditions.
      - a. Provide internal gutters and weep system to collect and drain water leakage and condensation to the exterior.
        - 1) Stick built curtain walls and punched windows shall have an isolated gutter cavity at each glass perimeter, so that leakage is confined to and weeped from the opening of leakage origin.
        - 2) Unitized curtain walls shall have continuous spliced gutters at horizontal stack joints, with sealed end caps at termination conditions.
        - 3) Horizontal ribbon windows shall have a continuous gutter and weep holes at the glass sill, and a continuous gutter at the glass head that drains directly to exterior or directs leakage from spandrel above to the window sill.
      - b. Provide continuous subsill below windows with interlocking mullions.
      - c. Coordinate gutter and weep systems with drainage provisions of other sections.
      - d. Give special attention to the connection of drainage members at columns, spandrel beams and other areas of limited access.

- G. Thermal Movements: Allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures:
  1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
  2. Test Interior Ambient-Air Temperature: 75 deg F (24 deg C).
  3. Test Performance: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
  4. Buckling, opening of joints, glass breakage, undue stress on fasteners, failure of sealants or any other detrimental effects due to thermal movement of components will not be permitted.
  5. Fabrication, assembly and erection procedures shall take into account the ambient temperature range at the time of respective operation.

- H. Energy Performance: Glazed aluminum curtain walls shall have certified and labeled energy performance ratings in accordance with NFRC.

1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.49 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
  - a. Spandrel panel and framing areas shall have U-factor of not more than 0.075 Btu/sq. ft. x h x deg F.
2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.33 as determined according to NFRC 200.
3. Air Infiltration and Exfiltration: Maximum air leakage through fixed glazing and framing areas of 0.06 cfm/sq. ft. of fixed wall area as determined according to ASTM E283 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).
  - a. Provide operable windows with permanent resistance to air leakage complying with ASTM E783 requirements for types of windows indicated [through system of not more than 0.25 cfm/foot of crack length at 6.24 lbf/sq. ft. static-air-pressure difference].
4. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC- certified condensation resistance rating of no less than 55 as determined according to NFRC 500.
5. Provide a complete and uninterrupted vapor barrier separate from or combined with the other wall barrier systems.
6. Thermal performance shall be based on following criteria:

	<b>Dry Bulb</b>	<b>Wet Bulb</b>
a. Summer Outside Air Temperature	83° F	63° F
b. Winter Outside Air Temperature	38.8° F	--
c. Summer Inside Air Temperature	75° F	62.5° F
d. Winter Inside Air Temperature	72° F	54° F
e. Summer relative humidity	50%-60%	

- I. Sound Transmission: Provide glazed aluminum curtain walls with fixed glazing and framing areas having the following sound-transmission characteristics:
  1. Outdoor-Indoor Transmission Class: Minimum 30 when tested for laboratory sound transmission loss according to ASTM E90 and determined by ASTM E1332.

- J. Anchorage and Structural Support Framing:
  1. Anchors and supports indicated and/or noted on drawings are schematic and do not necessarily indicate the exact and/or required scope, type, shape or profile.
    - a. Additional anchorage and structural support framing shall be added or complemented as required.
  2. Points of Support for Assemblies: Shall be properly braced in three orthogonal directions (vertical, transverse and longitudinal) to resist loads from any direction, including, but not necessarily limited to, the "positive and negative wind pressures" [and "seismic loads"].
  3. Anchorage and Support Framing: Shall be designed to accommodate thermal and building movements without harmful effect to curtain wall system, including glass and glazing materials, and sealant applications.
  4. Anchors (bracing, inserts, clips, bolts, etc.): Shall be designed for same loads as curtain wall and checked at 1.5 x "Design Wind Pressure" in addition to all other forces to ensure that the stresses do not exceed the yield point or elastic buckling, whichever is lower.
  5. Holes: Shall not be burned or field drilled in any structural steel members unless approved in writing by Architect.

- K. Critical Dimensions: The following critical dimensions shall be utilized without modification.
1. Wall Assembly Depth: Provide a complete wall system as shown and specified with components and systems located within the area from the exterior face to the depth noted as wall assembly depth, beam or edge of slab shown, without encroachment or displacement of the interior construction and finishes shown.
    - a. Anchorage zone is detailed using depth as indicated on the drawings or 3" minimum depth.
    - b. Wall zone is defined by manufacturer's glazed aluminum curtain wall system depth.
    - c. Combined wall zone and anchorage zone is wall assembly depth.
- L. Fire, Smoke and Draft Barrier: Provide a continuous fire, smoke and draft barrier as an integral component of the glazed aluminum curtain wall systems to prevent the passage of air and smoke from one floor to another, within the glazed aluminum curtain wall work.
1. Comply with the requirements of the authorities having jurisdiction, including testing and certification requirements.
  2. Design the barrier system to accept floor fire safing as an integral part of the system.
  3. Design the barrier to sustain the impact from a fire hose stream in accordance with the requirements of the local authorities having jurisdiction.
  4. Design the barrier system to withstand the loading from wind pressurization created by drainage openings and weep holes.
  5. Install continuous sealant above fire safing to effectively seal and prevent air loss between floors.
  6. Comply with UL Des CW-D-2039, to provide a 2-hour fire integrity rating at spandrel glass areas and UL Des CW-S 2002 at metal panel areas.
- M. Glass Replacement Requirements:
1. Glazing details shall permit glass replacement after initial construction, shall permit reuse of original gaskets, shall permit replacement glass of same nominal size as original glass, and shall not require cutting of framing members or removal of interior finishes.
  2. Vision glass in conventional frames shall be replaceable from exterior.
  3. Spandrel glass shall be replaceable from exterior.
  4. Silicone supported vision glass shall be replaceable from exterior.
- N. Snap Components Requirements:
1. Snap engaged components shall be secured against migration, and shall not serve any primary structural function, such as retention of glass or panels.
  2. Snap engaged plastic components are not permitted, except as nonstructural thermal improvement for interior trim.
  3. Joints in continuous snap covers and other continuous trim shall have splice sleeves of same material and finish as cover or trim.
- O. Dead load of glass and panels shall not be carried through thermal breaks.

## 1.6 SUBMITTALS

- A. Submit the following according to Conditions of the Construction Contract and Division 1 Specification Sections.
- B. Preliminary Design Proposals:
1. Submit a "preliminary design proposal" with Bid, including drawings and structural calculations for review of basic concept of curtain wall system, which shall be prepared, sealed and signed by a professional structural engineer registered in the state in which this Project is located.
    - a. Drawings shall include framing members, glass, components and sufficiently detailed information for proper evaluation.
    - b. Structural analysis data shall be complete as specified in this section under "Shop Drawings".
  2. Do not submit shop drawings and other submittals until "preliminary design proposal" is accepted by Architect and Owner.
- C. Submittal Requirements for Sound Transmission Controlled Assemblies:
1. Submit independent laboratory test data substantiating that all configurations of glazed aluminum curtain wall to be supplied to the Project, when installed will satisfy the Sound Transmission Loss performance requirements as described in the above Sound Transmission Controlled Assemblies paragraph of the System Description Article when tested in accordance with ASTM E90.
- D. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.



- E. LEED Submittal:
1. MR 4.1 and 4.2 – List of Proposed materials with recycled content: Indicate projected materials cost, projected post-industrial (pre-consumer) recycled content, and projected post-consumer recycled content for each product projected to have recycled content.
  2. MR 5.1 and 5.2 – Product Certificates for Credit: For products and materials required to comply with requirements for regional materials, certificates indicating location of material manufacturer and point of extraction, harvest, or recovery for each raw material. Include statement indicating distance to Project, cost for each regional material, and fraction by weight that is considered regional.
  3. Credit EQ 4.1: Product Data for glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.
- F. Shop Drawings: For glazed aluminum curtain walls. Include plans, elevations, sections, full-size details, and attachments to other work.
1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
  2. Include full-size isometric details of each vertical-to-horizontal intersection of glazed aluminum curtain walls, showing the following:
    - a. Joinery, including concealed welds.
    - b. Anchorage.
    - c. Expansion provisions.
    - d. Glazing.
    - e. Flashing and drainage.
  3. Include laboratory mockup Shop Drawings showing details of laboratory mockup.
    - a. Resubmit Shop Drawings with changes made to glazed aluminum curtain walls to successfully complete preconstruction testing.
  4. Structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation. Structural calculations shall include the following:
    - a. Shall be prepared, sealed and signed by the same professional structural engineer, registered in the State of California that signed the submitted shop drawings.
    - b. Shall include but not be limited to the justification of all glazed aluminum curtain wall elements, fasteners, miscellaneous accents, sunshade and anchorage components for compliance with criteria established in Contract Documents, including magnitude of allowable structural deflections at all principal framing elements and structural analysis of all connections in static and dynamic modes, in compliance with the City of San Francisco Building Code, structural calculations, manufacturer's recommendations, and Contract Documents.
    - c. Shall be cross-referenced to shop drawings and include all computations and information required for design and fabrication of glazed aluminum curtain wall elements.
    - d. Review of structural calculations for conformance with performance criteria by the Architect or the Owner's or Architect's Consultants shall not relieve Contractor from responsibilities and requirements for the performance specified for the Work of this Section.
    - e. Shall be submitted with each set of "preliminary design proposal" and shop drawings.
  5. Full compliance with requirements of this section, applicable codes, Contract Documents and structural calculations as required in this section.
  6. Compliance and coordination with "glass and glazing documentation" approved by glass manufacturer as specified in this section.
  7. Plans, elevations, sections, full size details of curtain wall framing members and components, complete with references to detail numbers on architectural drawings and references to Specification section and paragraph numbers to identify material types and finishes.
  8. Types, sizes, shapes, materials and quality of all components required to complete the curtain wall work.
  9. Method of anchorage to structure, joints and connections, method of assembling sections, details of curtain wall components coordinated with all adjoining work.
  10. Types of welded connections using AWS welding symbols.
  11. Layout of anchorage devices.
  12. Fabrication and erection tolerances for the work of this section and adjoining work.
  13. Direction and magnitude of thermal expansion, and the direction and magnitude of applicable building movements.
  14. Types of sealants, backer rods and other sealing materials required to make curtain wall watertight and airtight, clearly indicating compliance with Division 7 Section "Joint Sealants."
  15. Weeps, baffles and internal sealing methods.
  16. Maximum and minimum size joint gaps.
  17. Types and thicknesses of glass and glazing material.

18. Type and mil thickness of finish for exposed aluminum surfaces of curtain wall.
19. Type of finish for concealed accessories and components.
20. Continuous air and vapor barrier.
21. Continuous insulation.
22. Components intersection details.
23. Reinforcing: Corners of frames, inserts, anchors, etc.
24. Reglazing sequence.
25. Isolation of dissimilar materials.
26. Types, sizes and details of all shims, slip pads, gaskets, seals, setting blocks, edge blocks and fasteners.
27. Type and finish of metal panels including method of attachment.
28. Types of hardware and mounting heights.
29. Window washing provisions.

G. Samples for Initial Selection: For units with factory-applied color finishes.

H. Samples for Verification: For each type of exposed finish required, in manufacturer's standard sizes.

I. Office Samples:

Item No.	Quantity	Size	Description
S1	12	6"x6"	Each approved color range in specified finish of each extrusion and sheet for color coordination with other finishes. Use same method for samples that will be used in final application.
S2	5	6" long	Aluminum extrusions with specified finish and color used in curtain wall as selected by Architect. Use same method for samples that will be used in final application.
S3	5	6"x6"	Field touch-up to match specified finish and color.
S4	5	6" long (cured)	Sealants complete with respective primers, each type and color as specified in Division 7 Section "Joint Sealants."
S5	5	6" long	Waterproofing and glazing gaskets, including molded corners, tapes, setting blocks, jamb shims, backer rods and separators, each type.
S6	5	Actual	Anchor assemblies, each type.
S7	5	Actual	Fasteners, including accessory items such as washers, nuts, etc., each type.
S8	1	Actual	Composite corner cutaway sample incorporating all major components of curtain wall including glass, insulation, sealants and adjacent finish material at 4 locations as selected by Architect.

NOTE: Sample S8 shall include a vertical expansion joint, horizontal (stack) expansion joint, a typical head horizontal to mullion, a mullion splice and a mullion with fixed and expanding anchor. Cutaway shall be finished and shall show the elements in their final position. Cutaway sample shall be submitted only when all other samples and shop drawings have been accepted by Architect.

J. Preconstruction Mockup Submittals:

1. Preconstruction Testing Program: Developed specifically for Project.
2. Preconstruction Test Reports: Prepared by a qualified preconstruction testing agency for each mockup test.
3. Photographs:
  - a. Take a minimum of 10 photographs at locations and intervals as required by Architect.
  - b. Submit digital color images on CD-R of mockup before, during, and after preconstruction testing.

4. Record Drawings: Submit record drawings of preconstruction mockups prepared by preconstruction testing agency.
  - K. Qualification Data: For qualified Installer and testing agency.
  - L. Seismic Qualification Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
    1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
  - M. Welding certificates.
  - N. Energy Performance Certificates: For glazed aluminum curtain walls, accessories, and components, from manufacturer.
    1. Basis for Certification: NFRC-certified energy performance values for each glazed aluminum curtain wall.
  - O. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified preconstruction testing agency, for glazed aluminum curtain walls, indicating compliance with performance requirements.
  - P. Field quality-control reports.
  - Q. Maintenance Data: For glazed aluminum curtain walls to include in maintenance manuals.
  - R. Warranties: Sample of special warranties.
  - S. Glass and Glazing Documentation:
    1. Submit to glass manufacturer detailed diagrams, schedules and all information required for proper evaluation of glazing methods, wind load, wall and building movement, magnitude of thermal expansion, blocking, sealing, surface preparation and other procedures which may affect the curtain wall system for compliance with requirements of this section, applicable codes and Contract Documents.
    2. Verify with glass manufacturer and coordinate with Division 8 Section "Glass and Glazing."
  - T. As-Built Drawings:
    1. Required as specified in this section under "Mock-Up Panel Construction" for mock-up and building work.
    2. Submit 6 copies to Architect.
  - U. Operations and Maintenance Data: Shall clearly indicate manufacturer's printed instructions for operations and maintenance of installed work, including methods and frequency recommended for maintaining optimum condition under anticipated use conditions and precautions against materials and methods which may be detrimental to finishes and performance.
  - V. Certifications of Application: Submit one copy of certification in an approved form, stating that the completed glazed aluminum curtain wall complies with these specifications, that the component parts were properly designed or selected for the application made, and that installation methods complied with manufacturer's printed instructions and their field representatives' verbal instructions, and were proper and adequate for the condition of installation and use in each case, signed by the Contractor, the manufacturer and installer or the glazed aluminum curtain wall work.
  - W. Hazardous Materials Notification: In the event no product or material is available that does not contain asbestos, PCB or other hazardous materials as determined by the Owner, a "Material Safety Data Sheet" (MSDS) equivalent to OSHA Form 20 shall be submitted for that proposed product or material prior to installation.
  - X. Asbestos and PCB Certification: After completion of installation, but prior to Substantial Completion, Contractor shall certify in writing that products and materials installed, and processes used, do not contain asbestos or polychlorinated biphenyls (PCB), using format in Article 3 of General Conditions.
- 1.7 DELIVERY, STORAGE, AND HANDLING**
- A. Comply with General Conditions and Division 1 Section "Product Requirements."
    1. Deliver materials in manufacturer's unopened containers fully identified with manufacturer's name, trade name, type, class, grade, size and color.
    2. Factory-finishes shall be protected from abrasion and other damages.

3. Stacking and storing of components in shop, in transit and at Project site shall be done using softeners and timbers to keep individual members free from contact with the ground, and with each other.
4. Store materials in unopened containers, off ground, under cover and protected from damage.
5. Protect components from soiling by adjacent fabrication or construction operations.
6. Handle materials so surfaces are protected and distortion is prevented.
7. Materials which are delivered to Project site disfigured, cracked, chipped, or scratched, or otherwise not suitable for installation shall be removed from Project site and replaced with new materials at no additional cost to Owner.

### 1.8 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for glazed aluminum curtain walls by field measurements before fabrication and indicate measurements on Shop Drawings.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating glazed aluminum curtain wall systems without field measurements.
    - a. Coordinate construction to ensure that actual dimensions correspond to established dimensions.
    - b. Field verify dimensions and locations of existing elements abutting curtain wall systems.
  2. Coordinate glazed aluminum curtain wall work with the work of other sections and provide items to be placed during the installation of other work at the proper time to avoid delays in the work.
    - a. Place such items, including inserts and anchors, accurately in relation to the final location of glazed aluminum curtain wall components.

### 1.9 WARRANTY

- A. Comply with General Conditions and Division 1 Section "Product Requirements", except extend to 10 years, agreeing to repair or replace specified materials or Work that has failed within the warranty period. Failures include but are not limited to the following:
1. Abnormal deterioration, aging or weathering of the Work.
  2. Failure of anchorage metals due to oxidation, electrolytic damage and deterioration of protective coatings.
  3. Loose or missing parts.
  4. Failure of operating and moving parts and components to function properly.
  5. Leakage of water or air exceeding specified limits.
  6. Failure of tapes, gaskets or sealants.
  7. Glass breakage.
  8. Failure to conform to profiles, locations, arrangements shown on drawings.
  9. Failure to conform to manufacturer's recommendations and industry standards as they apply to the various curtain wall components.
  10. Staining of curtain wall surfaces caused by incompatibility of adjacent materials.
  11. Objectionable appearance or performance resulting from either defective or nonconforming materials or workmanship.
  12. Structural failure.
  13. Loss of glass bite due to shifting of glass.
  14. Loss of glass bearing on setting blocks due to shifting of glass and/or blocks.
  15. Collapse of thermal insulation or shifting insulation.
  16. Failure to conform to the Sound Transmission Control requirements.
- B. Special Assembly Warranty: Standard form in which manufacturer agrees to repair or replace components of glazed aluminum curtain walls that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
    - a. Structural failures including, but not limited to, excessive deflection.
    - b. Noise or vibration created by wind and thermal and structural movements.
    - c. Deterioration of metals and other materials beyond normal weathering.
    - d. Water penetration through fixed glazing and framing areas.
    - e. Failure of operating components.
  2. Warranty Period: 10 years from date of Substantial Completion.
- C. Special Finish Warranty: Standard form in which manufacturer agrees to repair finishes or replace aluminum that shows evidence of deterioration of factory-applied finishes within specified warranty period.
1. Deterioration includes, but is not limited to, the following:
    - a. Color fading more than 5 Hunter units when tested according to ASTM D2244.
    - b. Chalking in excess of a No. 8 rating when tested according to ASTM D4214.
    - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.

- 2. Repair warranty shall start after all related repair work is completed.
- 3. Repairs shall not change the design and appearance of interior and exterior face of curtain wall.
- 4. Warranty Period: 20 years from date of Substantial Completion.
  
- D. Glass and Glazing Warranty: Submit in accordance with Division 8 Section "Glazing" as part of curtain wall work.
  
- E. Sealant Warranty: Submit in accordance with Division 7 Section "Joint Sealants" as part of curtain wall work.
  
- 1.10 EXTRA MATERIAL**
- A. Deliver to Project site 6 pieces of each type of extrusions in lengths required for reglazing of each shape of glass.
  - 1. Crate and label as required.
  - 2. Place in storage location as directed by Owner.

**PART 2 PRODUCTS**

**2.1 UNAUTHORIZED MATERIALS**

- A. Materials and products required for work of this section shall not contain asbestos, polychlorinated biphenyls (PCB) or other hazardous materials identified by the Owner.

**2.2 MATERIALS**

- A. Aluminum:
  - 1. Extrusions: Provide shapes and thicknesses indicated and required to fulfill performance requirements; not less than 1/8" thick, unless otherwise indicated.
    - a. Tolerances: Finish, fabricate and assemble materials in accordance with standard commercial tolerances except for cross-sectional dimensions, for which one-half of commercial tolerances shall apply.
      - 1) Comply with applicable commercial tolerances published in Alcoa Aluminum Handbook.
  - 2. Sheets and Plates: Provide sizes and minimum gauges indicated and required to fulfill performance requirements; not less than 1/8".
    - a. Tolerances: Fabricate and assemble material in accordance with industry standard commercial tolerances except for flatness, for which the following tolerances shall apply.

Longitudinal or Transverse Distant Feet  
Center to Center of Buckles or Edge Wave ★

<u>0 to 2'</u>	<u>2' to 3'</u>	<u>3' to 4'</u>	<u>4' to 6'</u>	<u>Over 6'</u>
3/32"	3/16"	1/4"	5/16"	3/8"

★ Also applicable to overall length or width of sheet if only one longitudinal and/or transverse buckle or edge wave is present.

- B. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM and prepare surfaces according to applicable SSPC standard.
  - 1. Structural Shapes, Plates, and Bars: ASTM A36/A 36M.
  - 2. Cold-Rolled Sheet and Strip: ASTM A1008/A 1008M.
  - 3. Hot-Rolled Sheet and Strip: ASTM A1011/A 1011M.
  
- C. Stainless Steel: Shall conform to American Iron and Steel Institute's "Steel Products Manual" and the following:
  - 1. Annealed AISI Types 301, 302, 304 and 316: ASTM A167.
  - 2. AISI Type 430: ASTM A176.
  - 3. Tempered AISI Type 301 and Similar: ASTM A666.
  - 4. Tubing, AISI Type 430: ASTM A268.
  - 5. Tubing, AISI Types 304 and 316: ASTM A269.
  - 6. Hot-Rolled and Cold Finished Bars: ASTM A276.
  - 7. Plate, Sheet and Strip, AISI Types 201 and 202: ASTM A666.
  - 8. Rolled Shapes, Plates and Bars: ASTM A572.
  - 9. Cold-Rolled Sheet and Strip: ASTM A606.
  - 10. Hot-Rolled Sheet and Strip: ASTM A607.

11. Recycled Content: For materials containing post-industrial (pre-consumer) and/or post-consumer recycled content, contractor shall document the cost and percentage (by weight) of each material broken out by post-industrial (pre-consumer) and post-consumer content.
12. Regional Content: For material that is extracted, harvested or recovered as well as manufactured within 500 miles of the project site – 101 First Street, San Francisco, CA, contractor shall document the cost and percentage (by weight) of each material that is regional.
13. VOC Content: Adhesive and sealants used inside the waterproofing system and applied onsite shall have VOC content equal to or less than the applicable VOC limits. Refer to Section 01 81 13 / Sustainable Design Requirements for additional information.

## 2.3 FRAMING

- A. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- B. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials. Fabricated from 300 Series stainless steel.
  1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
  2. Reinforce members as required to receive fastener threads.
  3. Exposed Fasteners: Will be permitted only where approved by Architect.
    - a. When exposed fasteners are accepted, use 300 Series stainless steel with countersunk flat head or button head, Phillips Drive, finished to match adjacent metal and finish.
  4. Finish exposed portions to match framing system.
  5. At movement joints, use slip-joint linings, spacers, and sleeves of material and type recommended by manufacturer.
- C. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch (25.4 mm) that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
  1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A123/A 123M or ASTM A153/A 153M requirements.
  2. Shall be of type, size, alloy, quantity and spacings as required to meet structural design requirements.
  3. Bolts and Other Fastening Devices: Type 304 non-magnetic stainless steel.
    - a. Self-drilling, self-threading fasteners or screws in plugs are not permitted.
  4. Anchor Bolts: Self-locking type complete with nylon inserts.
    - a. Liquid or other setting types of locking compounds are not permitted.
- D. Concealed Flashing: Dead-soft, 0.030" or thicker stainless steel, ASTM A240/A240M, Type 300 Series or 0.040" or thicker aluminum sheet.
- E. Framing Sealants: Manufacturer's standard sealants.
- F. Weeps:
  1. Type: Weep holes shall be baffled against water infiltration which will not degrade under sunlight, water and fungus conditions, complete with attachments.
  2. Size: Conform to weep hole size, profiles and arrangements.
  3. Weep Baffles: PVC coated open cell reticulated urethane foam; 30-40 pores per inch.
  4. Weeps in snap covers shall be 3/8" oblong openings.
- G. Shim Types:
  1. Stainless steel 300 series.
  2. Hot-dipped galvanized steel, ASTM A36 or ASTM A283 quality.
  3. High impact polystyrene.
    - a. Do not use at structural connections.
  4. For Structural Connection: Use only metal shims.
  5. U-Shaped Shims: Do not use at structural connections, slip connections or other locations where shims can become loose.
  6. Fiber Shims: Not acceptable.

- H. Separators:
  - 1. At Expansion Connections: Use Penn Fibre's "Nylatron", or other approved type, of thickness required to meet design requirements.
    - a. Slip pads are required at all surfaces which are subject to movement.
  - 2. Between Dissimilar Materials and at Dynamic Connections: Use rigid high-impact polystyrene with smooth surfaces each side, of thickness required to meet design requirements.
  - 3. Do not use polystyrene in close proximity of field welds.
- I. Window Washing Anchors: Concealed mounted in framing components; spaced as indicated on drawings.
- J. Dissimilar Materials: Where encountered, use only stainless steel 300 series.
- K. Top of Tower Parapet Coping: Insure that thickness of metal coping is no less than 3/16" to serve as a ground for the lightning protection system in Division 16.
- L. Terminator at Aluminum Composite Panel System: Extruded aluminum.
- M. Framing Gaskets: As recommended by manufacturer for joint type.

## 2.4 GLAZING

- A. Glazing: Comply with Division 8 Section "Glazing."
- B. Glazing Gaskets: Comply with Division 8 Section "Glazing."
- C. Glazing Sealants: Comply with Division 8 Section "Glazing".
  - 1. Provide sealants for use inside of the weatherproofing system that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.5 METAL PANELS

- A. Metal Panels General:
  - 1. Type: Aluminum and stainless steel cladding elements as detailed on the drawings.
    - a. Cladding Elements: Formed edge flanges as detailed.
    - b. Backside Stiffener Members: As required to maintain flatness.
  - 2. Cladding elements, when supported in the same manner as intended in the building, shall be capable of carrying the design load without suffering any permanent deformation or damage.
  - 3. Exterior Faces Flatness: Cladding elements shall be of such flatness that, when measured at room temperature, the maximum slope of the surfaces at any point, measured from the nominal plane of the surface in its final installed position shall not exceed:
    - a. 0.25% for surfaces having finish of high reflectivity.
    - b. 0.35% for surfaces having a finish of medium reflectivity.
    - c. 0.5% for surfaces having a finish of low reflectivity.
  - 4. Cladding Material Inspection:
    - a. Inspect for physical tolerances including length, width, squareness, and camber on one sheet of each box that is shipped.
    - b. Inspect for flatness tolerances on each coil until the tension leveling setup is achieved and afterward, on one sheet of each box.
    - c. The acceptable limits shall be as follows:
      - 1) Evaluate deviation of panel from the flat surface at each corner and center of each side to 0.065" maximum deviation on any corner or side.
        - a) This would approximate a 0.35% off-flat condition.
        - b) Long edges and center buckle in sheets are unacceptable conditions.
      - 2) Lay sheet on flat table good side down.
        - a) Evaluate deviation of panel from the flat surface at each corner and center of each side to 0.090" maximum deviation on any corner or side.
          - b) This would approximate a 0.05% off-flat condition.
          - c) Long edge and center buckle of sheets are unacceptable conditions.
      - 3) Stand sheet on edge (i.e. free standing).
        - a) Using a straight edge, check coil set and canoe shape to 1/4" maximum canoe and 3/8" maximum coil set.

- B. Metal Panel: Roof Screen Panel #1:
1. Type: Perforated aluminum. Perforation pattern #1 as indicated on the drawings.
  2. Thickness: As required to meet the design loads, but not less than 1/8".
  3. Finish: Fluoropolymer coating as specified in Division 9 Section "High Performance Architectural Coatings."
  4. Color: Aluminum Color AL-4.
  5. Drawing Designation: AL-4.
  6. Location: Office tower top.
- C. Metal Panel: Roof Screen Panel #2:
1. Type: Perforated aluminum. Perforation pattern #2 as indicated on the drawings.
  2. Thickness: As required to meet the design loads, but not less than 1/8".
  3. Finish: Fluoropolymer coating as specified in Division 9 Section "High Performance Architectural Coatings."
  4. Color: Aluminum Color AL-5.
  5. Drawing Designation: AL-5.
  6. Location: Office tower top.
- D. Metal Panel: Roof Screen Panel #2 (Alternate Option):
1. Type: Stainless Steel. Perforation pattern #2 as indicated on the drawings.
  2. Thickness: As required to meet the design loads, but not less than 1/8".
  3. Finish: Brushed, finish level and grain orientation to be determined.
  4. Drawing Designation: SS-2.
  5. Location: Office tower top.
- E. Metal Panel: Bridge Fascia Panel:
1. Type: Flush aluminum with formed edges.
  2. Thickness: As required to meet the design loads, but not less than 1/8".
  3. Finish: Fluoropolymer coating as specified in Division 9 Section "High Performance Architectural Coatings."
  4. Color: Aluminum Color AL-6A.
  5. Drawing Designation: AL-6A.
  6. Location: Bridge fascia.
- F. Metal Panel: Podium Wall Panel:
1. Type: Perforated aluminum. Perforation pattern #3 as indicated on the drawings.
  2. Thickness: As required to meet the design loads, but not less than 1/8".
  3. Finish: Fluoropolymer coating as specified in Division 9 Section "High Performance Architectural Coatings."
  4. Color: Aluminum Color AL-6B.
  5. Drawing Designation: AL-6B.
  6. Location: Floors 1-5, South Wall.
- G. Metal Panel: Shadowbox Panel.
1. Type: Flush aluminum panel with formed edges.
  2. Thickness: As required to meet the design loads, but not less than 1/8".
  3. Finish: Fluoropolymer coating as specified in Division 9 Section "High Performance Architectural Coatings."
  4. Color: Aluminum Color AL-7.
  5. Drawing Designation: AL-7.
  6. Location: Floors 2-5, Shadowbox.
- \* H. Metal Panel: Lobby Wall Exterior:
- \* 1. Type: Flush aluminum with formed edges.
  - \* 2. Thickness: As required to meet the design loads, but not less than 1/8".
  - \* 3. Finish: Fluoropolymer coating as specified in Division 9 Section "High Performance Architectural Coatings."
  - \* 4. Color: Aluminum Color AL-6A.
  - \* 5. Drawing Designation: AL-6A.
  - \* 6. Location: Exterior return walls adjacent to Lobby.
- \* I. Metal Panel: Lobby Wall Interior:
- \* 1. Type: Flush aluminum panel with formed edges.
  - \* 2. Thickness: As required to meet the design loads, but not less than 1/8".
  - \* 3. Finish: Fluoropolymer coating as specified in Division 9 Section "High Performance Architectural Coatings."
  - \* 4. Color: Aluminum Color AL-6A.
  - \* 5. Drawing Designation: AL-7.
  - \* 6. Location: Lobby interior.



**2.6 EXTERIOR TRIM**

- A. Exterior Trim: Stainless steel complying with ASTM A666, Type 302, 304, or 316 requirements; with No. 4 finish; and in profiles indicated.
- B. Tube Cap on Sunshade: Drawing designation SS-1.
  - 1. Finish: Brushed; finish level and grain orientation to be determined.

**2.7 ACCESSORY MATERIALS**

- A. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil (0.762-mm) thickness per coat.
- B. Perimeter Fire-Containment Systems (Safing Insulation): Specified in Division 7 Section "Fire-Resistive Joint Systems".
  - 1. Type/Thickness: As specified and indicated on drawings or required to meet code requirements.
    - a. Comply with UL Des CW-D-2039 at spandrel glass areas and UL Des CW-S-2002 at metal panel areas], to provide a 2-hour fire integrity rating.
  - 2. Support Brackets: Galvanized steel type required at 12" on centers to support safing insulation.
    - a. Reduce spacings of brackets as required to assure positive retention of insulation.

**2.8 CURTAIN WALL SYSTEM**

- A. Type: Glazed curtain wall of aluminum framing system designed and fabricated to meet all requirements of this section, approved shop drawings, curtain wall manufacturer's published recommendations and Contract Documents.
  - 1. Code Compliance: San Francisco Building Code.
- B. Joints and Corners:
  - 1. Shall be flush, hairline, weatherstripped, accurately fitted together and sealed watertight.
  - 2. Metal-to-Metal Joints between curtain wall elements shall be thoroughly cleaned, primed and sealed by buttering joints with silicone sealant immediately prior to the final assembly of abutting sections.
  - 3. Clean excess sealant from exposed surfaces.
  - 4. Expansion Joints: Shall be designed and constructed to allow full-service life of weatherseal without premature failure.
- C. Connections and Supporting Devices:
  - 1. Field Connections: Concealed type.
  - 2. Exposed Connectors and Sealants: Not acceptable.
  - 3. Supporting Devices: Galvanized steel or aluminum, with provisions for two dimensional adjustment; [aluminum devices are not acceptable for structural connections.
  - 4. Include instructions for setting or welding devices in place.
- D. Sleeves, Lugs, Related Items:
  - 1. Install in a full bed of non-curing sealant and seal perimeter when component is in final installed position.
  - 2. Clean excess sealant from exposed surfaces.
  - 3. Contour Sleeves: Shall be extruded aluminum sections designed to interlock accurately with adjacent sections for secure bedding of sealant between metal and sleeve.
- E. Removable Members:
  - 1. Removable members such as glass stops, fillers or closures shall be extruded and shall be securely engaged into adjacent components.
  - 2. Extrusions shall be fitted to eliminate edge projection or misalignment at joints.
- F. Condensation Drains: Required with frame construction to drain moisture to exterior.
  - 1. Gutter and drainage assemblies shall be stainless steel.
- G. Curtain wall components to be painted after fabrication so that cut edges receive the specified finish.

**2.9 METAL PROTECTION MATERIALS**

- A. General:
1. Materials used as permanent or temporary protection for metals shall conform with the following standards and coating systems.
  2. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations relative to applying primer.
- B. Corrosion-Inhibiting Paint for Carbon Steel:
1. For Concealed Parts Not Subject to Moisture: 2 shop coats minimum 1 mil thickness each coat of zinc chromate primer complying with FS TT-P-645 or zinc-rich paint.
  2. For Exposed Parts Subject to Moisture: Zinc-rich paint conforming to SSPC-PS 1, SSPC-PS 2 or SSPC-PS 3.
- C. Prime Paint:
1. Protection against galvanic action shall be provided wherever dissimilar metals are in contact.
  2. Provide minimum dry film thickness of one mil for zinc chromate and 30 mils for bituminous paint.
  3. Pretreatment: SSPC-Paint 27 if required for specified painting system.
  4. Bituminous Paint: FS TT-C-494.
  5. Cold-Applied Asphalt Mastic: SSPC-Paint 12.
  6. Zinc-Rich Paint: MIL-P-38336.
  7. Zinc-Chromate Primer: FS TT-P-645.
- D. Galvanizing of Carbon Steel:
1. ASTM A653: Hot-dip for steel sheets.
  2. ASTM A123: Hot-dip for shapes, plates, bars and strip.
  3. ASTM B633: Electro-galvanizing.
- E. Dissimilar Metals: Separate dissimilar metals with bituminous paint, or a suitable sealant, or a nonabsorptive plastic or elastomeric tape, or a gasket between the surfaces.
1. Do not use coatings containing lead.

**2.10 FABRICATION**

- A. Form or extrude aluminum shapes before finishing.
- B. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- C. Fabricate components that, when assembled, have the following characteristics:
1. Profiles that are sharp, straight, and free of defects or deformations.
  2. Accurately fitted joints with ends coped or mitered.
  3. Physical and thermal isolation of glazing from framing members.
  4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
  5. Provisions for field replacement of glazing from exterior.
  6. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
  7. Components curved to indicated radii.
- D. Fabricate components that, when assembled, have the following characteristics:
1. Pressure-equalized system or double barrier design with primary air and vapor barrier at interior side of glazed aluminum curtain wall and secondary seal weeped and vented to exterior.
- E. Factory-Assembled Frame Units:
1. Rigidly secure nonmovement joints.
    - a. Reinforce members and joints with steel plates, bars, rods or angles for rigidity and strength needed to fulfill performance requirements.
    - b. Use concealed stainless steel fasteners for jointing which cannot be welded.
    - c. Reinforce aluminum mullions and assemblies as required to support loads from window washing equipment.
  2. Seal joints watertight unless otherwise indicated.
    - a. Separate dissimilar metals or alloys with heavy coating of bituminous paint or other suitable permanent separation required to prevent galvanic action.
  3. Install glazing to comply with requirements in Division 8 Section "Glazing."

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

## 2.11 FINISHES

- A. Curtain Wall Exterior Finish:
1. Fluoropolymer coating as specified in Division 9 Section "High Performance Architectural Coatings".
  2. Drawing Designation Aluminum Color AL-1.
  3. Locations of color numbers are indicated on drawings.
- B. Curtain Wall Interior Finish:
1. Fluoropolymer or Thermosetting polyester coating as specified in Division 9 Section "High Performance Architectural Coatings".
  2. Drawing Designation Aluminum Color AL-2.
  3. Locations of color numbers are indicated on drawings.
- C. Brushed Stainless Steel Finish:
1. Type: General purpose bright mechanically polished "Brushed Finish", No. 4, obtained by finishing with a 120-150 mesh abrasive, following initial grinding with coarser abrasive, complete with protective coating, in accordance with quality standards and methods established by NAAMM to match "control sample" approved by Architect.
  2. Protective Coating: Temporary strippable type factory-applied coating for protection of exposed finish.
  3. Finish Designations on Drawings:
    - a. **SS-1**: Brushed finish; finish level and grain orientation to be determined.
      - 1) Location: Tube cap at Sunshade.
    - b. **SS-2**: Brushed finish; finish level and grain orientation to be determined.
      - 1) Location: Perforated panel at Tower Top.
    - c. **SS-3A**: Brushed finish; finish level and grain orientation to be determined.
      - 1) Location: Lobby wall tubes.
    - d. **SS-3B**: Brushed finish; finish level and grain orientation to be determined.
      - 1) Location: Lobby wall perforated plate.
    - e. **SS-3C**: Brushed finish; finish level and grain orientation to be determined.
      - 1) Location: Lobby wall tension rod.
    - f. **SS-3D**: Brushed finish; finish level and grain orientation to be determined.
      - 1) Location: Lobby wall base.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Proceed with installation only after unsatisfactory conditions have been corrected.
  2. Surfaces shall be free of frost, condensation, dirt, grime or other foreign materials which will hinder or create conditions which prevent proper installation or performance of curtain wall.
  3. Review with Architect field dimensions which are in conflict with approved shop drawings.

### 3.2 INSTALLATION

- A. General:
1. Comply with manufacturer's written instructions.
  2. Do not install damaged components.
    - a. Do not erect members which are warped, bowed, deformed or otherwise damaged to such extent as to impair strength or appearance.
    - b. Remove and replace members damaged in the process of erection.
  3. Fit joints to produce hairline joints free of burrs and distortion.
  4. Cutting and trimming components of the glazed aluminum curtain wall during erection is prohibited.
    - a. Do not cut through structural steel or concrete reinforcing.
  5. Set units level, plumb and true to line, with uniform joints.
    - a. Support on metal shims and secure in place by bolting to clip angles and similar supports anchored to supporting structure.
    - b. Use only types of equipment, ropes, wedges, etc. and other items during erection which will not stain or mark finish of units.

- c. Ensure placement of shims will not interfere with continuity of gaskets and seals.
  6. Rigidly secure nonmovement joints.
  7. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
  8. Weld components in concealed locations to minimize distortion or discoloration of finish.
    - a. Protect glazing surfaces from welding.
    - b. Remove all slag, and thoroughly clean welds and adjoining burned areas of prime coated surfaces.
    - c. Repaint with one coat of zinc-rich paint for welds.
    - d. Grind exposed welds smooth, using only clean wheels and compounds which are free of iron or iron compounds.
      - 1) Restore finish of components after welding and grinding.
    - e. Solder and braze only to fill or seal joints (not to form structural joints) and in accordance with component manufacturer's recommendations.
      - 1) Grind smooth and restore finish.
  9. Seal joints watertight unless otherwise indicated.
- B. Metal Protection:
1. Where aluminum will contact dissimilar metals, protect against galvanic action by painting contact surfaces with primer or by applying sealant or tape or installing nonconductive spacers as recommended by manufacturer for this purpose.
  2. Where aluminum will contact concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within glazed aluminum curtain wall to exterior.
- D. Install components plumb and true in alignment with established lines and grades.
- E. Install glazing as specified in Division 8 Section "Glazing."
1. Weep holes, gutters and drainage channels shall remain free of dirt, rubbish, sealants and other materials prior to closing of the wall.
  2. Glazing rabbets shall be clean, dry and free of materials which will affect the proper bond and seal of glazing materials or affect the proper drainage of glazing rabbets.
- F. Install sealants as specified in Division 7 Section "Joint Sealants."
1. Where sealants are installed by several trades, i.e. glazed aluminum curtain wall, glazing, aluminum panel installation, prior to commencing such work, coordinate sealant work with adjacent sealant work of other installers, relative to scheduling and sequencing of work and compatibility of materials used by each trade.
  2. Seal joints in glazed aluminum curtain wall in a concealed manner.
    - a. Exposed sealants of metal to metal joint are not permitted.
- G. Install insulation materials as specified in Division 7 Section "Building Insulation."
1. Comply with requirements of Division 7 Section "Building Insulation", unless otherwise indicated.
- H. Install perimeter fire-containment systems (safing insulation) as specified in Division 7 Section "Fire-Resistive Joint Systems".
1. Clean debris from behind glazed aluminum curtain wall during erection and provide temporary closures to prevent accumulation of debris.
  2. Install safing insulation with securely anchored metal flanges or make equivalent provisions to prevent dislocation.
  3. Comply with UL Des CW-D-2039 at spandrel glass areas and UL Des CW-S-2002 at metal panel areas, to provide a 2-hour fire integrity rating.
- I. Install metal flashing and accessories required for watertight installation.
1. Install metal flashings in 8' lengths joined with flat locked soldered seams.
  2. Provide expansion joints not over 25' on centers with loose lock filled with sealant
    - a. Stagger flashing joints so as not to align with joints in exterior.
    - b. Stagger sill flashing so that joint does not align with expansion or stack joint in mullions.

**3.3 ERECTION TOLERANCES**

- A. Erection Tolerances: Install glazed aluminum curtain walls to comply with the following maximum tolerances:
- B. Erection Tolerances: The following tolerances are not accumulative and represent maximum deviations for total building height and length dimensions.
1. Amount of total deviation or misalignment in any direction for vertical members: 1/8" maximum in 26'-0" or a maximum of 1/4" in 52'-0".
  2. Amount of total deviation or misalignment in any direction for horizontal members: 1/8" maximum in a 25' run.
  3. Maximum offset from true alignment between two abutting members will be 1/32".
    - a. Edge projection will not be permitted.
  4. Maximum joint gap or opening between removable glazing stop, filler or closure and its adjacent member will be 1/16" or a maximum 1/16" cumulative opening at both ends of removable members (1/32" at each end).
  5. Spandrels, Column Covers, Panels, Doors, Door Facings, Parapets, Roof and Access Doors: Deviation from flat for faces of panels shall not exceed 1/16" in 10' at any location and 1/8" total for the entire face.
  6. Where tolerances dictated by the window washing system equipment supplier exceed those specified above, comply with the more restrictive requirement.
  7. Allowances for the cumulative effect of all tolerances (fabrication, assembly, thermal, building, and erection) and including the work of other sections, shall be made to ensure a weatherproof installation.
    - a. The documentation and distribution of this information to the applicable installation and inspection personnel are essential to ensure compliance with Contract Documents.
- C. Tolerances for Glass Framing Members:
1. Squareness: Not more than 1/8" difference in the length of the diagonals of an opening.
  2. Corner Offset: Limited to maximum 1/32".
  3. Bow: Should not exceed 1/16" for every 6 ft. of framing length.

**3.4 FIELD QUALITY CONTROL**

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
1. Contractor shall be responsible for the following:
    - a. Coordinate with ITL so they can properly schedule any inspections and tests.
    - b. Furnish casual labor required to facilitate testing.
    - c. Inform ITL and Architect at least one day prior when work is to be performed.
    - d. Provide material samples and access to materials as required for testing.
    - e. Contractor is responsible for expense of testing or inspection resulting as consequence of the following:
      - 1) Work not evidencing compliance with Contract Documents.
      - 2) Testing to verify adequacy of work done without prior notice, improper supervision, or contrary to standard construction practice.
  2. Contractor shall provide ITL with the following:
    - a. Complete set of shop and erection drawings.
    - b. Cutting lists, order sheets, material bills, shipping bills and mill test reports.
    - c. Information as to time and place of fabrication and shipment of material to shops.
    - d. Representatives sample pieces requested for testing.
    - e. Full and ample means of assistance for testing materials.
    - f. Proper facilities, including scaffolding, temporary work platforms, hoisting facilities, etc., for inspection of work in shop and field.
- B. Testing Services: Testing and inspecting of representative areas of glazed aluminum curtain walls shall take place as installation proceeds to determine compliance of installed assemblies with specified requirements.
1. Air Infiltration: Areas shall be tested for air leakage of 1.5 times the rate specified for laboratory testing in "Performance Requirements" Article, but not more than 0.50 cfm/sq. ft. (2.25 L/s per sq. m), of fixed wall area when tested according to ASTM E783 at a minimum static-air-pressure differential of 6.24 lbf/sq. ft. (300 Pa).
    - a. Test Area: Not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall including stack joint.
    - b. Perform a minimum of two tests in areas as directed by Architect, on three separate occasions, prior to 10, 35, and 70 percent completion.
  2. Water Penetration: Areas shall be tested according to ASTM E1105 at a minimum cyclic static-air-pressure differential of 15 psf without reduction, and shall not evidence water penetration.
    - a. Test Area: Not less than 30 feet (9.1 m), by one story of glazed aluminum curtain wall including stack joint.
    - b. Perform a minimum of two tests in areas as directed by Architect, on three separate occasions, prior to 10, 35, and 70 percent completion.

3. Water Spray Test: Before installation of interior finishes has begun, areas designated by Architect shall be tested according to AAMA 501.2 and shall not evidence water penetration.
    - a. Testing Areas: Not less than 20' nor more than 40' x 1 story high.
      - 1) Location: Where approved by Architect.
    - b. Perform a minimum of 3 field water tests.
    - c. First Test: Take at initial installation.
    - d. Second Test: Take at 50% completion.
    - e. Third Test: Take at 80% completion.
  - C. Glazed aluminum curtain walls will be considered defective if they do not pass tests and inspections.
  - D. Notify Architect and Owner, in writing, a minimum of 14 days prior to conducting field testing.
    1. Remove interior finishes to allow for observation during testing.
    2. Replace interior finishes after conclusion of testing.
  - E. Test Reports and Photographs: Required for field testing.
  - F. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
    1. Corrective work shall be approved by Architect before re-testing.
    2. Corrective work and retesting shall be paid by Contractor with no additional cost to Owner, including testing fees, Architect's and Consultant's fees.
  - G. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- 3.5 ADJUSTMENTS, CLEANING, PROTECTION**
- A. Adjustment: After repeated operation of completed installation, readjust operable window operators and other hardware for optimum condition and safety.
  - B. Damage to Finish:
    1. Factory-applied finishes which are scratched, abraded, or damaged during transport, delivery, storage or erection, shall be removed or repaired as directed by and to the satisfaction of the Architect.
    2. Repair work to the factory-applied finish shall match the sample approved by Architect.
  - C. Protection:
    1. Coat exposed stainless steel surfaces at ground level with strippable paper.
    2. Provide board protection at ground level work and near construction chutes.
    3. Temporary coating and coverings provided at Contractor's option to protect work during shipment, storage, erection and construction, shall avoid development of no-uniformity or other deleterious effects in work.
    4. Remove protection requested by Architect for inspections of finishes and replace.
    5. Confirm compatibility of protective coatings or residue of strippable coating, with manufacturer(s) or elastomeric sealants to be applied in field.
  - D. Cleaning:
    1. Upon completion of work, remove protective coverings from exposed surfaces, and clean surfaces of excess sealants and discoloration.
      - a. Cleaning shall be in accordance with requirements of the applicable manufacturers of materials.
      - b. Cleaners shall be compatible with materials and glazed aluminum curtain wall components and shall be acceptable to the manufacturers of related materials.
    2. Remove mortar, plaster, fireproofing and other deleterious material from surfaces of aluminum immediately.
    3. Care shall be exercised when cleaning the exterior portions of the building to protect other Work and sealant to metal joint work.
    4. Debris caused by or incidental to the installation work shall be promptly removed.
    5. Weep holes and drainage channels shall be checked and left unobstructed, free of dirt, rubbish and sealants.
    6. The finished installation of the work included herein shall be free of defects.
      - a. Before final completion and acceptance of the building, the Contractor shall repair and/or replace at the Contractor's own expense any and all defective work, to the satisfaction of the Owner and Architect.
  - E. The completed glazed aluminum curtain wall system shall be secure, watertight, airtight, rattle-free and in full compliance with Contract Documents.

**PART 4 MOCK-UP TEST PANELS****4.1 MOCK-UP PANEL CONSTRUCTION**

- A. General:
1. Full-size mock-up test panels of typical Project conditions shall be constructed for required testing specified in this section.
  2. Build mockup of typical wall area as indicated on drawings.
  3. Mock-ups shall accurately represent typical Project conditions using materials, colors, finishes, anchorage, etc., approved by Architect.
  4. Each mock-up test panel shall be constructed by the appropriate trade and coordinated with curtain wall requirements for compliance with approved shop drawings and Contract Documents.
  5. The mock-ups shall, as nearly as possible, simulate the actual installation, including reasonable representations of profiles of adjacent building elements.
  6. Thermal insulation is required as part of mock-up unit to be installed just prior to thermal test.
  7. Provide extra items and material as may be required for replacements.
  8. Do not start construction of mock-up test panels before receiving approved shop drawings from Architect.
- B. Notification:
1. Notify Architect and Owner, in writing, a minimum of 30 days prior to construction of mock-up test panels.
  2. Do not proceed until approved by Architect and Owner.
- C. Air Chamber:
1. Construct the air chamber with observation ports of sufficient size and number to permit thorough examination of all interior surfaces and joints of the test assembly during the actual test periods in accordance with safety requirements of testing agency.
  2. The interior of air chamber shall be made accessible so that close inspection of test assembly can be conducted during and following the water penetration and structural performance tests in accordance with safety requirements of testing agency.
  3. Chamber Temperature: Not less than 40° and not higher than 80°.
- D. As-Built Drawings:
1. "As-built" drawings of mock-up panels shall be complete with actual dimensions and thicknesses of all components including actual measured sizes of glass panels, to 1/32" of width and height and .001" for thickness.
  2. "As-built" drawings shall be submitted with test reports.
  3. Reference copies of "as-built" drawings shall be available to Architect and Owner during testing.

**4.2 MOCK-UP PANEL TESTING GENERAL**

- A. Testing Facilities: Owner will select one of the following laboratories:
1. Mid-American Testing Laboratory/St. Louis, Missouri.
  2. Construction Research Laboratory/Miami, Florida.
  3. Construction Consulting Laboratory/Dallas, Texas or Ontario, CA.
  4. Architectural Testing, Inc., York, Pennsylvania or Fresno, CA
  5. Smith Emery/ Los Angeles, CA.
- B. Notification:
1. Notify Architect and Owner, in writing, a minimum of 30 days prior to testing the mock-up test panels.
  2. Written notification shall include a complete and detailed description of proposed testing facilities, including experience of personnel who will perform testing and a step-by-step outline of test procedures.
  3. Testing Procedures shall be complete with schematic diagrams describing location of deflection gauges for "Structural Performance Testing".
  4. Do not start testing before written notification and testing procedures have been reviewed and accepted by Architect and Owner.
- C. Test Reports: Shall include but not be limited to the following:
1. Type and date of testing.
  2. Complete testing activities and test results of each type of testing.
  3. When retesting is required, indicate the type of corrections made and results of retesting.

- D. Photographs:
1. Before starting the required testing, take a minimum of 2 photos of each side of the completed test assembly.
  2. Take a sufficient number of photos to adequately document all required testing.
  3. Photo Type/Size: Digital photos, clearly marked with Project name, test date and description of view.
- E. Testing shall utilize suitable instruments and gauges calibrated and positioned to indicate actual face pressure of glass, and to record deflections of glass, mullions and other aluminum components.
1. Water pressure shall be calibrated with pressure gauges.

#### 4.3 TEST MOCK-UPS

- A. General:
1. Furnish labor and materials to build and test mock-ups as shown on Drawings.
    - a. Mock-ups shall accurately represent project conditions including joints, sealants, glass, glazing, anchors and finishes.
    - b. Install sufficient thermal insulation and staffing insulation to demonstrate details of installation.
    - c. If thermal test is required, install all thermal insulation.
    - d. Delay installation of any such safing and thermal insulation until the air, water and structural design load tests are successfully completed.
  2. Each mock-up shall be glazed with one consistent set of gaskets.
    - a. Use of multiple gasket profiles and/or thicknesses at the contractor's discretion is not permitted.
  3. Prior to tests, remove and reglaze glass units selected by the Architect, using the details and procedures intended for glass replacement on the actual building.
    - a. Reglazed units must satisfy all test criteria.
    - b. Contractor may submit for approval a request to waive this requirement for glass supported by structural silicone.
  4. Provide at least one extra glass unit for each type and size on mock-ups.
    - a. Glass that breaks during testing shall be replaced with new glass and the tests continued.
    - b. Repeated glass breakage shall constitute failure.
  5. Do not start construction of mock-up test panels before receiving approved mock up shop drawings from Architect.
    - a. Each mock-up test panel shall be constructed by the appropriate trade and coordinated with curtain wall requirements in compliance with approved shop drawings and Contract Documents.
    - b. Deviations from or additions to details shown on shop drawings are subject to approval.
  6. Testing laboratory shall conduct and report all tests, shall state in the report whether test specimen conforms to requirements of Contract Documents, and shall note deviations from mock-up drawings.
    - a. Contractor shall provide to laboratory 'as-built' mock-up drawings within two weeks of completion of testing, for attachment to laboratory report.
  7. If failures occur, revise and retest mock-ups.
    - a. Modifications must be realistic in terms of project conditions, must maintain standards of quality and durability and are subject to prior approval.
  8. If failures necessitate retests, contractor shall pay the additional laboratory fees and other fees and expenses, including architect's and consultant's fees.
  9. Testing facilities acceptable, subject to availability of equipment and qualified personnel to perform specified tests. Other laboratories may be submitted for approval.
    - a. Construction Research Laboratory, Miami, Florida.
    - b. Architectural Testing Inc. York, Pennsylvania.
    - c. Mid America Testing, St. Louis, Missouri.
  10. Mock-ups are subject to observation by Owner, Architect and their consultants during construction and testing.
    - a. Provide a minimum of two weeks notice before beginning construction of mock-ups.
    - b. Provide materials and personnel for prompt continuous construction of mock-ups.
    - c. Contractor shall coordinate chamber availability, shipping schedules and mock-up construction schedules directly with the laboratory.
    - d. The interior of air chamber shall be made accessible so that close "hands on" inspection of test assembly can be conducted during and following the water penetration and structural performance tests in accordance with safety requirements of testing agency. Chamber temperature shall be not less than 40 degrees F and not higher than 80 degrees F.
  11. The testing laboratory shall not perform any of the following functions:
    - a. Act as consultant to a contractor for this project.
    - b. Modify Contract Documents requirements.
    - c. Modify mock-up configuration.



- d. Dismantle mock-ups until notified that no further testing is required. Once notified to proceed with dismantling, the laboratory shall document and record as built conditions observed during dismantling of specimen and note any discrepancies between the as tested wall and the as built mock-up shop drawings.
  12. Undocumented tests are not permitted.
    - a. All test results, including static water and air infiltration pre-testing of specimen and chamber during the de-bugging of the chamber and all remedial work, shall be documented in the laboratory report.
  13. Typical mock-up design pressures as indicated on the drawings or as stated in the specifications as based upon the wind tunnel report.
  14. Testing procedures shall be completed with schematic diagrams describing location of deflection gauges for "Structural Performance Testing".
  15. Do not start testing before written notification and testing procedures have been reviewed and accepted by Architect.
- B. Testing shall utilize suitable instruments and gauges calibrated and positioned to indicate actual face pressure of glass, and to record deflections of glass, mullions and other aluminum components.
1. Water volume shall be calibrated.

#### 4.4 MOCK-UP TESTS

- A. Testing Sequence:
1. Preload at 50% of inward typical design pressure.
  2. Air infiltration at 6.24 psf (ASTM E283).
  3. Water infiltration (static pressure) at 15 psf (ASTM E331).
  4. Water infiltration (dynamic pressure) at 15 psf (AAMA 501.1).
  5. Structural test at (50%) and (100%) of inward typical design load (ASTM E330).
  6. Structural test at (50%) and (100%) of outward typical design load (ASTM E330).
  7. Repeat air infiltration at 6.24 psf (ASTM E283).
  8. Repeat static water infiltration test (item 3 above).
  9. Structural test at (50%) and (100%) of inward corner (see Note "A") design load (ASTM E330).
  10. Structural test at (50%) and (100%) of outward corner (see Note "A") design load (ASTM E330).
  11. Repeat air infiltration at 6.24 psf (ASTM E283).
  12. Repeat static water infiltration test (item 3 above).
  13. Thermal Cycle Test: Subject specimen to three hot and cold cycles, maintaining equilibrium for 1 hour between each phase of the cycle, to demonstrate compliance with the thermal criteria specified in this glazed aluminum curtain walls specification.
  14. Repeat static water infiltration test (item 3 above).
  15. Tieback:
    - a. Apply 600 pounds outward for at least 10 seconds.
    - b. Apply 600 pounds side load in both directions for at least 10 seconds.
    - c. There shall be no failure or gross permanent distortion of tieback receptacle or pin, track engagement or of any other part of the wall.
    - d. Wall shall be subjected to 1.52 psf negative pressure during the tieback testing.
  16. Structural test at (75%) and (150%) of typical inward design load (ASTM E330).
  17. Structural test at (75%) and (150%) of typical outward design load (ASTM E330).
  18. Structural test at (75%) and (150%) of corner (see Note "A") design load (ASTM E330).

Note "A": When "corner area" design wind load testing is required, special reinforcement of those typical (non-corner area) test specimen framing members which were not specifically engineered to resist "corner area" wind loads may be necessary. Locations of these members and the details of any such special reinforcing shall be shown on the mock up shop drawings for review prior to testing.

- B. Air leakage test shall conform to ASTM E283.
1. Different static test pressure shall be 6.24 PSF.
  2. Chamber leakage shall accurately be determined, not estimated.
  3. Air infiltration of fixed wall are shall not exceed 0.06 CFM/ft<sup>2</sup> of projected exterior surface.
- C. Where test sequence or test failure requires successive water infiltration tests, the only means used to drain water from internal cavities shall be gravity drainage through weep system for a minimum of 15 minutes.
1. Air pressure, removal of parts or other means of draining water shall not be used.

- D. Static water infiltration test shall conform to ASTM E331.
  - 1. Differential test pressure shall be 15 PSF.
  - 2. There shall be no unacceptable water leakage as defined herein.
  - 3. Sources of water leakage shall be identified.
  
- E. Dynamic water infiltration test shall conform to AAMA 501 except as otherwise specified herein.
  - 1. There shall be no unacceptable water leakage as defined herein.
  - 2. Sources of water leakage shall be identified.
  
- F. Structural tests shall conform to ASTM E330.
  - 1. Deflection gages shall be set to zero prior to each application of pressure at 50, 75, 100 and 150 percent of design pressures.
  - 2. Deflection gage readings shall be recorded after each application of pressure.
  - 3. Deflection measurements are not required for initial preload.
  - 4. Specified deflection and set limitations apply to one application of pressure, not to cumulative effects of two or more loadings.

**END OF SECTION**