PRODUCT SPECIFICATION GUIDE **DATE: SEPTEMBER 2016**

 **VENTEX MODEL 2410/2415 EXTRUDED ALUMINUM LOUVER**

 C.S.I. SUBGROUP: DIVISION 23, HVAC (PREVIOUSLY DIVISION 15)

# PART 1 - GENERAL

* 1. **GENERAL INSTRUCTIONS**
		1. Read and conform to:
			1. The General Conditions of the Project Agreement and Project Documents.
			2. Instructions to Bidders prepared by Design Build Contractors.
		2. Comply with Section 01 10 00, Architectural General Requirements and documents referred to herein.

# SUMMARY

* + 1. Section Includes: Provide louvers including but not limited to following:
			1. Additional steel support framing.
			2. Extruded aluminum prefinished wall louvres.
			3. Bird screens.
			4. Insect screens.
			5. Caulking.
		2. Related Sections: Following description of work is included for reference only and shall not be presumed complete:
			1. Provision of concrete walls: Section 03 30 00, Cast-In-Place Concrete.
			2. Provision of masonry: Section 04 20 00, Masonry Units.
			3. Provision of curtain wall system: Section 08 44 00, Curtain Wall.

# REFERENCES

* + 1. Abbreviations and Acronyms:
			1. AMCA: Air Movement and Control Association International, Inc.; [www.amca.org.](http://www.amca.org/)
			2. MSDS: Material Safety Data Sheets.
			3. PVDF: Polyvinylidene Fluoride.
			4. SSPC: The Society for Protective Coatings (formerly known as Steel Structures Painting Council); [www.sspc.org.](http://www.sspc.org/)
		2. Reference Standards:
			1. AAMA 2605-05 - Voluntary Specification, Performance Requirements and Test Procedures for Superior Performance Organic Coatings on Aluminum Extrusions and Panels

2. AMCA 500-L - Laboratory Methods of Testing Louvers for Rating

3. AMCA 511 – Certified Ratings Program for Air Control Devices.

4. ASTM B26/B26M-09 - Standard Specification for Aluminum-Alloy Sand Castings

5. ASTM B209 (ASTM B209M) - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate

6. ASTMB211 Standard for Aluminum Bar, Rod and Wire

7. ASTM B244 - Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments

8. ASTM C920 - Standard Specification for Elastomeric Joint Sealants

9. ASTM D523 - Standard Test Method for Specular Gloss

10. ASTM D714 - Standard Test Method for Evaluating Degree of Blistering of Paints

11. ASTM D822/D822M - Standard Practice for Filtered Open-Flame Carbon-Arc Exposures of Paint and Related Coatings

12. ASTM D968 - Standard Test Methods for Abrasion Resistance of Organic Coatings by Falling Abrasive.

13. ASTM D1187-97(11)e1 - Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal

14. ASTM D2244 - Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates

15. ASTM D2247 - Standard Practice for Testing Water Resistance of Coatings in 100% Relative Humidity

16. ASTM D3363-05(11)e2 - Standard Test Method for Film Hardness by Pencil Test

17. ASTM D4214 - Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films

18. ASTM E488 - Standard Test Methods for Strength of Anchors in Concrete Elements

19. AWS D1.2/D1.2M - Structural Welding Code - Aluminum

20. CAN/CGSB 19.24-M90 - Multicomponent, Chemical-Curing Sealing Compound

21. CAN/ULC S702 - Standard for Thermal Insulation Mineral Fiber for Buildings

22. SEI/ASCE 7-10 - Minimum Design Loads for Buildings and Other Structures

23. CISC/CPMA 2-75 - A Quick-Drying Primer for Use on Structural Steel

24. CSA G40.20-04 - General Requirements for Rolled or Welded Structural Quality Steel

25. SSPC-05 - The Society for Protective Coatings, “Systems and Specifications, SSPC Painting Manual, Volume 2”

**1.4 COORDINATION**

A. Pre-Installation Conference: Conduct conference at project site.

1. Meet with Owner, Consultant, Structural Engineer, Mechanical Engineer and manufacturer's technical representative, concrete subcontractors and installers whose work interfaces with or affects louvers.

2. Review contract documents and associated trade shop drawings and specifications for the work and develop a complete understanding of the work including proper site and weather conditions, storage and handling of materials, surface preparation, installation of materials, sequencing quality control, restrictions on areas of work and other matters affecting construction. Also discuss:

a. Sequencing and coordinating installation of anchorages embedded in concrete or

masonry, precast or metal siding system construction.

b. Support conditions including alignment between and attachment to structural members.

 **1.5 SUBMITTALS**

A. Product Data: For each type of product indicated.

1. Printed catalog pages showing specified models with appropriate Air Movement and Control Association International (AMCA) Certified Ratings Seals.

2. Manufacturer's product data including performance data.

3. Preparation instructions and recommendations.

4. Storage and handling requirements and recommendations.

5. Installation methods.

B. Shop Drawings:

1. Submit Shop Drawings for work of this Section in accordance with Division 01. In addition to minimum requirements indicate following:

a. Structural supports and framing provided as part of this Section.

b. Provision for structural and thermal movement between louvres and adjacent materials.

c. Show mullion profiles and locations weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion, Provision for structural and thermal movement between louvers and adjacent materials. Indicate pressure drop, face area, and free area.

2. Employ a registered structural engineer specified herein is responsible for:

a. Production and review of Shop Drawings.

b. Stamping and signing each Shop Drawing and any associated calculations performed.

C. Samples:

1. Samples for Initial Selection: Samples of units with factory-applied colour finishes.

2. Submit duplicate colour samples for each type of louver.

3. Submit samples in accordance with Division 01. Submit following samples in sizes indicated:

a. Louvers minimum 600 mm (24") square with all components.

b. Louver flashing minimum 300 mm (12") square.

D. Delegated-Design Submittal: For louvers indicated to comply with performance requirements and design criteria. Include Shop Drawings, analysis data and design calculations signed and sealed by the qualified professional engineer responsible for their preparation.

1. Include sizes, yield strengths, gauge thicknesses and joint spacing to allow thermal movement and loading of components.

E. Product Test Reports: Based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

F. Certificates:

1. Obtain certificate from Professional Engineer responsible for design which includes seismic assessment and field review of this part of the Work, validating that work substantially complies with the requirements of the applicable building code and that requisite field reviews have been completed.

**1.6 CLOSEOUT SUBMITTALS**

A. Cleaning and Maintenance Manual.

B. Maintenance Submittals:

1. Before completion of the works, submit four (4) copies of a Maintenance Manual in accordance with Division 01 to include:

a. Recommended periodic inspection and maintenance schedule.

b. A copy of each shop drawing in its latest amended form.

c. Complete explanation of operation principles and sequences.

d. Complete parts list, with numbers and sizes.

e. Method statement of replacement of component parts of the installation.

f. Instructions for the proper cleaning and routine maintenance of all components.

 **1.7 QUALITY ASSURANCE**

A. Source Limitations: Obtain louvers and vents from single source from a single manufacturer where indicated to be of same type, design, or factory-applied color finish.

B. Welding: Qualify procedures and personnel according to the following:

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

C. Sheet Metal and Air Conditioning Contractor’s National Association (SMACNA) Standard: Comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details, and installation procedures.

D. Qualifications:

1. Installers: Provide work of this Section executed by competent installers with minimum of 5 years experience in application of products, systems and assemblies specified and with approval and training of the product manufacturers.

2. Licensed Professionals: Employ a professional structural engineer carrying a minimum of $2,000,000.00 professional liability insurance and registered in the relevant jurisdiction in accordance with requirements of Division 01 to:

a. Design components of The Work of this Section requiring structural performance.

b. Be responsible for full assemblies and connections.

c. Be responsible for determining sizes, joint spacing to allow thermal movement and loading of components in accordance with applicable codes and regulations.

d. Be responsible for production and review of Shop Drawings.

e. Inspect work of this Section during fabrication and erection.

f. Stamp and sign each Shop Drawing.

g. Establish seismic design criteria based on:

1. Anticipated ground motion.

2. Soil type in specific geographic area.

3. Occupancy category.

**1.8 PROJECT CONDITIONS**

A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

B. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

**1.9 DELIVERY, STORAGE AND HANDLING**

A. Delivery and Acceptance Requirements: Coordinate deliveries to comply with construction schedule and arrange for strategic off-the-ground, undercover storage locations.

B. Storage and Handling Requirements:

1. Properly wrap louvres with protective coverings and put in suitable crates to prevent distortion and damage. Carefully unload, handle and store to prevent damage.

2. Protect work of this Section from damage. Protect other work from damage resulting from this Work. Repair or replace damaged work to satisfaction of Consultant at no cost to Owner.

**1.10 WARRANTY**

A. Manufacturer Warranty: Warrant work of this Section against defects and/or deficiencies in accordance with General Conditions of the Contract. Promptly correct any defects or deficiencies which become apparent within warranty period, to satisfaction of Consultant and at no expense to Owner. Defects include but are not limited to extensive colour fading.

B. Warranty, High Performance Organic Coatings: Submit a warranty for a period of 20 years, warranting integrity of film and permanence of color of high performance organic coatings for following:

1. Color fade not to exceed 5 Δ E units (Hunter) as calculated in accordance with ASTM D2244 on exposed surfaces cleaned with clean water and a soft cloth.

2. Degree of chalking not to exceed rating No. 8 when measured in accordance with ASTM D4214 on exposed unwashed surfaces.

3. Will not crack, check or peel.

**PART 2 - PRODUCTS**

**2.1 MANUFACTURERS**

A. Manufacturer List: Products of following manufacturers are acceptable subject to conformance to requirements of Drawings, Schedules and Specifications:

1. **Ventex Inc., Bolton, Ontario www.ventexinc.com**

B. Substitution Limitations: Comparable Products from other manufacturers not listed herein may be accepted provided they meet requirements of this Specification after full review by Consultant before bidding closes.

**2.2 PERFORMANCE DESIGN CRITERIA:**

A. Description:

1. Regulatory Requirements: Provide a Pre-Start Health and Safety Review in accordance with the Occupational Health and Safety Act (Ontario), Regulation 851, as amended. Refer to Division 01 for further requirements.

B. Design Criteria:

1. Delegated Design: Design louvers, including comprehensive engineering analysis by a qualified professional engineer, licensed in Ontario using structural and seismic performance requirements and design criteria indicated.

2. Design louver, screens and grilles in accordance with building code and to withstand live, dead, lateral, wind, seismic, handling, transportation and erection loads, imposed and other loads.

3. Provide for positive drainage to outside of any water entering joints and exterior face of system.

C. Performance Criteria:

1. Louvers licensed to bear AMCA Certified Ratings Seal. Ratings based on tests and procedures performed in accordance with AMCA 511 and comply with AMCA Certified Ratings Program. AMCA Certified Ratings Seal applies to air performance and water penetration ratings.

2. Material thicknesses stated herein are a minimum. Be responsible for engineering calculations to ensure structural adequacy of wall louvres.

3. Structural Performance: Withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louvre components or deflection greater than L/180 of span between the support, without noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Provide integral reinforcing ribs to prevent bowing and distortion. Wind pressures shall be considered to act normal to the face of the building. Determine loads based on pressures indicated below:

 a. Wind Loads: Design louvres to withstand maximum positive and negative wind loads, and address higher loads (hot spots) in accordance with the latest building code. The wind loads are based on fifty (50) year return period.

b. Employ a registered structural engineer specified herein to:

1. Design components for work of this Section requiring structural performance.

2. Be responsible for determining sizes, joint spacing to allow thermal movement and loading of components in accordance with applicable codes and regulations.

4. Seismic Performance: Design work of this Section to withstand seismic motions determined in accordance with requirements of Building Code.

5. Vibration Control: Louver members shall not vibrate when subjected to wind loading and/or adjacent to mechanical equipment. Provide integral bosses as required.

6. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

a. Temperature Change (Range): 67°C (120°F), ambient; 100°C (180°F) material surfaces.

7. Frame and Blade Nominal Thickness: Not less than 2.06 mm (0.081”) for blades and for frames unless otherwise indicated, to ASTM B211. Extruded aluminum alloy 6063-T5. Provide extruded aluminum blade supports in section modulus and depth to resist anticipated loads.

8. Mullion Type: As indicated in the Drawings to ASTM B211. Extruded aluminum alloy 6063-T5.

9. Head sill and jamb: minimum 2.06 mm (0.081”) thick aluminum.

**2.3 MATERIALS**

A. Aluminum Sheet: ASTM B209M, Alloy 3003 or 5005 with temper as required for forming, or as otherwise recommended by metal producer for required finish.

B. Aluminum Castings: ASTM B26/B26M, Alloy 319.

C. Fasteners: Use types and sizes to suit unit installation conditions.

1. Use Red Robertson or Tek screws for exposed fasteners unless otherwise indicated.

3. For colour-finished louvers, use fasteners with heads that match colour of louvres.

D. Anchoring Devices and Clips: Aluminum non-magnetic stainless steel or other noncorrosive metal compatible with aluminum. Steel anchors may be used provided they are zinc coated and insulated from aluminum.

E. Post installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors, made from stainless-steel components, with capability to sustain, without failure, a load equal to 4 times the loads imposed, for concrete, or 6 times the load imposed, for masonry, as determined by testing per ASTM E488, conducted by a qualified independent testing agency.

F. Sealant: Non-sag type, 1 component ultra-low modulus, pre-pigmented, neutral cure elastomeric silicone sealant conforming to ASTM C920, Type S, Grade NS, Class 100/50,

G. Structural Steel Supports: Supply new material conforming to CSA G40.20, Grade 300W, cleaned to SSPC-SP 3 requirements and shop primed with primer conforming to CISC/CPMA 2-75.

H. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D1187.

**2.4 MANUFACTURED UNITS**

A. High Performance louver based on **Ventex Model 2410 (Channel Frame) / 2415 (Flange Frame).**

1. Louvre Depth: 102 mm (4”).

2. Free Area: Not less than 53.2% for louver size 1219 x 1219 (48” x 48”).

3. Free area velocity at the point of beginning water penetration (@0.01oz. /ft² of free area based on a 15 minute interval test) not less than 627 FPM (3.19 m/s).

4. Air Performance: Not more than 0.16” w.g. exhaust pressure drop at 1000 fpm free-area velocity.

5. Assembly:

a. Factory assembled louver components. Mechanically fastened construction.

b. Design Load: Incorporate structural supports required to withstand wind load as required by building code.

c. Louvers shall be factory engineered to withstand the specified seismic loads.

 1. Minimum design loads shall be calculated to comply with ASCE – 7, or local requirements of Authority Having Jurisdiction.

B. Accessories:

1. Aluminum Insulated Blank-Off Panels: 51 mm (2 inch), aluminum skin, insulated core, factory installed with removable screws and neoprene gaskets. Provide extruded polystyrene insulation where used in insulated spaces. Finished to match louvers.

2. Bird Screen:

a. Aluminum, 13 mm x 13 mm (1/2 ” x 1/2”) mesh, 1.6 mm (0.063”), intercrimped.

b. Frame: Removable.

3. Extended Sills: Formed aluminum, minimum nominal wall thickness 1.02 mm (0.040”).

C. Fabrication:

1. Assemble louvers in factory to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

2. Provide louver blades with extruded aluminum blade supports in section modulus and depth to resist loads anticipated and meet design requirements specified. Provide integral reinforcing ribs to prevent bowing and distortion.

3. Accurately cut and fit components to produce tight hairline junctures. Securely fasten frame members together with adequate concealed welds (optional) and seal with sealant to ensure watertight joints.

4. Fabricate bird screens using aluminum mesh securely locked into a heavy aluminum channel frame. Install bird screens on the inside of louvres and screw fasten to frames to permit removal if required.

5. Coat surfaces of aluminum in contact with steel, concrete and/or masonry using specified bituminous coating.

**2.5 FINISHES**

A. General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Finish louvers after assembly.

C. Protect mechanical and painted finishes on exposed surfaces from damage by applying a removable, temporary protective covering before shipping.

D. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved samples. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

E. Aluminum Finishes: Where noted on the drawings as painted finish:

1. Exterior Finish: Superior Performance Coating Finish Process: (3 Coat Wet System) including thermal setting application of 70% fluoropolymer resin, PVDF with added colour pigment finish exceeding or meeting AAMA 2605 requirements. Ensure fluoropolymer baked resins form a continuous physically locked finish during manufacturing process. Apply fluoropolymer finish after multistage chemical treatment cleaning providing corrosion resistance surface ready to receive primer. During baking process apply primer in accordance with manufacturer’s recommendations followed by a flash process whereby evaporating solvent and then fluoropolymer finish sprayed on to aluminum; apply another flash procedure and then bake for approximately 10 minutes when aluminum surface reaches a temperature of 232 deg C (450 deg F). Apply clear topcoat, flash and bake procedures as specified herein.

a. Primer and fluoropolymer thermal setting enamel meeting or exceeding AAMA 2605 with minimum 70% fluoropolymer resin, PVDF, 3 coat system (primer/colour coat/clear coat); “Duranar XL” by PPG Industries Inc. or Kynar 500 equivalent by Arkema Inc.

Description Performance Characteristics

Coating Thickness (DFT): 0.0063 mm +/- 0.0013 mm (0.25 +0.05 mil) primer

0.025 mm (1.0 mil) min barrier coat (if applicable)

0.15 (1.0 mil) min colour coat

0.15 +/-0.0005 mm (0.6 +0.02 mil) clear top coat

Pre-Treatment: Multi-Stage Cleaning with Chrome Phosphate Conversion Coating 40 mg/ft2 min.

Gloss (ASTM D523) @60° Medium gloss

Pencil Hardness (ASTM D3363) F Minimum

Abrasion Resistance (ASTM D968) Falling Sand Test – 50 L/ml

Acid Resistance: (10% Muriatic Acid) 15 minutes – No attack

Alkali Resistance: Mortar Pat Test 100% R.H. @100 deg F. 24 hours – No attack.

Colour Retention: 10-Years South Florida or equivalent 45° (ASTM D2244) Max. 5ΔE

Gloss Retention: 10 years, South Florida or equivalent 45° Minimum of 50% after 5 years South Florida or equivalent

Corrosion Resistance: (4000 hr. Humidity / 5 % NaCl @ 100 deg F Salt Spray) 1/16” maximum undercutting

Chalking Resistance (ASTM D714): 10 Years South Florida 45° or equivalent) No more than #8 (#6 for Whites)

Film Adhesion: Dry Adhesion/Wet Adhesion/Boiling Water Adhesion

Erosion Resistance: (ASTM B244) - 10 Years South Florida 45° or equivalent) Maximum 5%

Humidity Resistance: ASTM D714, ASTM D2247, 4000 hrs, 100% R.H. @ 100°F: Few #8 blisters maximum

 b. Pretreatments: Recommended by organic finish coat manufacturer suitable for application and accepted by Consultant.

 c. Colours and Sheens: “To match consultant’s sample”.

2. Dielectric Separator: Apply a heavy coat of acid and alkali resistant bituminous paint on concealed surfaces of aluminum and galvanized steel in contact with structural steel, concrete, or masonry.

**2.6 SOURCE QUALITY CONTROL**

A. Tests and Inspections:

1. Structural Inspection: Ensure a registered structural engineer specified herein inspects work of this Section during fabrication.

**PART 3 - EXECUTION**

**3.1 EXAMINATION**

A. Verification of Conditions: Verify actual site dimensions and location of adjacent materials prior to commencing work. Notify Consultant in writing of any conditions which would be detrimental to the installation.

B. Evaluation and Assessment: Commencement of work implies acceptance of previously completed work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

**3.2 PREPARATION**

A. Coordinate setting drawings, diagrams, templates, instructions, and directions for installation of anchorages that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

**3.3 INSTALLATION**

A. Locate and place louvers and vents level, plumb, and at indicated alignment with adjacent Work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weathertight connection.

C. Secure angle reinforcing as an integral part of the assembly. Neatly mitre and weld corners at areas indicated.

D. Cut and fit components to produce tight hairline junctures. Securely fasten frame members together with concealed welds and seal with sealant to ensure watertight joints.

E. Provide perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

F. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

G. Protect unpainted galvanized and non-ferrous metal surfaces that will be in contact with concrete, masonry, or dissimilar metals from corrosion and galvanic action by applying a heavy coating of bituminous paint or by separating surfaces with waterproof gaskets or nonmetallic flashing.

H. Secure support frames to openings. Install louvers plumb or true to slope and at correct location in openings, with bird screens on inside. Method of attachment shall be concealed.

I. Install concealed gaskets, flashings, joint fillers, and insulation as louver installation progresses. Comply with Section 07 92 00 “Joint Sealants" for sealants applied during louver installation.

J. Apply sealant to perimeter of frames to adjacent materials or to supports using joint backing and sealant. Neatly tool and finish joints.

**3.4 SITE QUALITY CONTROL**

A. Site Tests and Inspections:

1. Structural Inspection: Ensure a registered structural engineer specified herein inspects work of this Section during erection/installation.

2. Independent inspection and testing company may be appointed and paid for by Owner to carry out inspection and testing as directed by Consultant. Refer to Division 01.

B. Non-Conforming Work: Replace damaged work which cannot be satisfactorily repaired, restored or cleaned, to satisfaction of Consultant at no cost to Owner.

C. Manufacturer Services: Arrange for product manufacturer’s technical representative to:

1. Meet and discuss installation procedures and unique conditions at the place of the work.

2. Inspect substrate surfaces and recommend solutions to accommodate adverse conditions.

3. Periodically visit and inspect installation and report unsatisfactory conditions.

 4. Attend final inspection and to submit written certification that products, systems and assemblies have been installed in accordance with manufacturer’s requirements.

**3.5 CLEANING**

A. Maintain aluminum work in a clean condition throughout construction period so that it will be without deterioration or damage at time of acceptance. Select methods of cleaning which will promote achievement of uniform appearance and stabilized colours and textures for materials that weather or age with exposure.

B. Clean exposed surfaces of louvres and vents that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

C. Before final inspection, clean exposed surfaces with water and a mild soap or detergent not harmful to finishes. Thoroughly rinse surfaces and dry.

D. Restore louvers and vents damaged during installation and construction so no evidence remains of corrective work. If results of restoration are unsuccessful, as determined by Consultant, remove damaged units and replace with new units.

E. Touch up minor abrasions in factory applied finishes with air-dried coating that matches color and gloss of, and is compatible with, factory-applied finish coating.

F. Demonstrate proper cleaning methods to Owner. Prepare a "Cleaning and Maintenance Manual" listing types of cleaning compounds and cleaning methods. Submit 2 copies to the Owner before Substantial Completion.

G. Immediately before time of Substantial Performance, clean aluminum work thoroughly, inside and out. Demonstrate proper cleaning methods to Owner during this final cleaning.

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**END OF SECTION**