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## SECTION 057313 - GLAZED DECORATIVE METAL RAILINGS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Section Includes:
  - 1. Glazed decorative metal railings.
- B. Related Requirements:

Retain subparagraph below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

- 1. Section 061000 "Rough Carpentry" for wood blocking for anchoring railings.

#### 1.2 DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

- A. Railings: Guards, handrails, and similar devices used for protection of occupants at open-sided floor and exterior deck areas and for pedestrian guidance and support, visual separation, or wall protection.

#### 1.3 COORDINATION AND SCHEDULING

- A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver items to Project site in time for installation.

#### 1.4 PREINSTALLATION MEETINGS

Retain "Preinstallation Conference" Paragraph below if Work of this Section is extensive or complex enough to justify a conference.

- A. Preinstallation Conference: Conduct conference at **[Project site]** <Insert location>.

## 1.5 ACTION SUBMITTALS

### A. Product Data:

1. Metal railings assembled from standard components.
2. Glass products.
3. Glazing cement and accessories for structural glass railings.
4. Sealant and accessories for structural glass railings.
5. Fasteners.
6. Wood rails.
7. Lacquer for copper alloys.
8. Shop primer.
9. Bituminous paint.
10. Nonshrink, nonmetallic grout.
11. Anchoring cement.

### B. Shop Drawings: Include plans, elevations, sections, and attachment details.

Retain "Samples for Initial Selection" and "Samples for Verification" paragraphs below for two-stage Samples.

### C. Samples for Initial Selection: For products involving selection of color, texture, or design[, **including mechanical finishes**].

### D. Samples for Verification: For each type of exposed finish required.

Delete or revise subparagraphs below.

1. Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
2. Base channel.
3. Each type of glass and glass edge required.
4. Fittings and brackets.
5. Assembled Samples of railing systems, made from full-size components, including top rail, post, handrail, [**structural glass balusters,**] [**and**] [**glass-infill panels**]. Show method of finishing members at intersections. Samples need not be full height.

Retain "Delegated Design Submittal" Paragraph below if design services have been delegated to Contractor.

### E. Delegated Design Submittal: For installed products indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.6 INFORMATIONAL SUBMITTALS

Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements." and as may be supplemented in "Quality Assurance"

Article.

- A. Qualification Data: For [professional engineer] [testing agency].

Usually, delete "Mill Certificates" Paragraph below unless increased corrosion resistance of Type 316 stainless steel is required.

- B. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

"Product Test Reports" Paragraph below may be used for verification of performance requirements in addition to providing engineering calculations. Retain only for manufacturers' standard products that are known to have been previously tested. For products that have not been previously tested, retain "Preconstruction test reports" Paragraph and "Preconstruction Testing" Article.

- C. Product Test Reports: For tests performed by a qualified testing agency, in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.
- D. Evaluation Reports: From ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.
1. For glazed decorative metal railings.
  2. For post-installed anchors.

Retain "Preconstruction test reports" Paragraph below if specifying preconstruction testing in "Preconstruction Testing" Article as Contractor's responsibility.

- E. Preconstruction test reports.

1.7 QUALITY ASSURANCE

- A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for fabrication and installation.

Retain one of first three subparagraphs below; revise to suit Project. Mockups may be designed as separate decorative elements and left in place if approved by Architect.

1. Build mockups as indicated on Drawings.
2. Build mockups for each form and finish of glass-infill panel railing consisting of two posts, top rail, handrail, glass-infill panel, and anchorage system components that are full height and are not less than 24 inches in length.
3. Build mockups for each form and finish of structural glass railing consisting of top rail, structural glass, base channel, and anchorage system components that are full height and are not less than 24 inches in length.

Retain subparagraph below if the intention is to make an exception to the default requirement in Section 014000 "Quality Requirements" for demolishing and removing mockups.

4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

#### 1.8 PRECONSTRUCTION TESTING

Retain this article for preconstruction testing. Project-specific preconstruction testing of assemblies can be expensive but may be the best means of proving that performance requirements are met. Some railing manufacturers have ICC-ES evaluation reports or test reports from other qualified testing agencies that show performance requirements are met. Coordinate with "Product Test Reports" Paragraph in "Informational Submittals" Article.

- A. Preconstruction Testing Service: **[Owner will engage] [Engage]** a qualified testing agency to perform preconstruction testing on laboratory mockups. Payment for these services will be made **[by Owner] [from the testing and inspecting allowance, as authorized by Change Orders] [by Contractor]**. Retesting of products that fail to meet specified requirements is to be done at Contractor's expense.

Indicate size and other details of laboratory mockups on Drawings or by inserts.

1. Build laboratory mockups at testing agency facility; use personnel, materials, and methods of construction that will be used at Project site.
2. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358.
3. Notify Architect **[seven] <Insert number>** days in advance of the dates and times when laboratory mockups will be tested.

#### 1.9 FIELD CONDITIONS

If possible, design railings so they do not have to fit other construction and delete this article.

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on Shop Drawings.

#### 1.10 WARRANTY

When warranties are required, verify with Owner's counsel that warranties stated in this article are not less than remedies available to Owner under prevailing local laws.

"Manufacturer's Special Warranty for Laminated Glass" Paragraph below is an example only; revise to suit Project.

- A. Manufacturer's Special Warranty for Laminated Glass: Glazed decorative metal railing manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge

separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.

Verify available warranties and warranty periods.

1. Warranty Period: [Five] [10] <Insert number> years from date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

Retain "Delegated Design" Paragraph below if Contractor is required to assume responsibility for design.

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazed decorative metal railings, including attachment to building construction.
- B. General: In engineering railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
  1. Aluminum: The lesser of minimum yield strength divided by 1.65, or minimum ultimate tensile strength divided by 1.95.
  2. Copper Alloys: 60 percent of minimum yield strength.
  3. Stainless Steel: 60 percent of minimum yield strength.
  4. Steel: 72 percent of minimum yield strength.

Retain "Glass" Subparagraph below for glass-supported railings. Requirement is based on the 2006 International Building Code (IBC) for safety factor of 4.

5. Glass: 25 percent of mean modulus of rupture (50 percent probability of breakage), as listed in "Mechanical Properties" in AAMA CW-12, "Structural Properties of Glass."
- C. Structural Performance: Railings, including attachment to building construction, are to withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

Three subparagraphs below are based on the IBC; revise to suit Project and to comply with requirements of authorities having jurisdiction.

1. Handrails and Top Rails of Guards:
  - a. Uniform load of 50 lbf/ft. applied in any direction.
  - b. Concentrated load of 200 lbf applied in any direction.
  - c. Uniform and concentrated loads need not be assumed to act concurrently.
2. Structural Glass Railings and Glass-Infill Panels:

- a. Concentrated load of **50 lbf** applied horizontally on an area of **1 sq. ft.**.
  - b. Infill load and other loads need not be assumed to act concurrently.
3. For structural glass railings, support each section of top rail [**and handrail**] by a minimum of three glass panels or by other means so railings will remain in place if any one glass panel fails.
- a. Support top rail [**and handrail**] ends such that railings remains in place if end glass panel fails.
- D. Wind Loads: For exterior glazed decorative metal railings, capable of withstanding the following wind loads in accordance with the IBC and ASTM E1300:
1. Wind Load: [**As indicated on Drawings**] <Insert wind load>.

Retain "Windborne-Debris-Impact Resistance" Paragraph below for exterior glazed decorative metal railings in hurricane-prone areas. The IBC establishes criteria for buildings in hurricane-prone locations. In paragraph, "enhanced" option applies to essential facilities and has additional requirements. Verify requirements of authorities having jurisdiction. Verify which manufacturers have tested products and can demonstrate compliance.

- E. Windborne-Debris-Impact Resistance: Exterior glazed decorative metal railings passing ASTM E1886 missile-impact and cyclic-pressure tests in accordance with ASTM E1996 for Wind Zone [**1**] [**2**] [**3**] [**4**] for [**basic**] [**enhanced**] protection.

Insert increased heights if different from those in "Large-Missile Test" and "Small-Missile Test" subparagraphs below. For enhanced protection, delete "Small-Missile Test" Subparagraph.

1. Large-Missile Test: For exterior glazing located within [**30 feet**] <Insert dimension> of grade.
2. Small-Missile Test: For exterior glazing located between **30 feet** and [**60 feet**] <Insert dimension> above grade.

Delete "Thermal Movements" Paragraph below if only interior railings are required.

- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

Differential values in "Temperature Change" Subparagraph below (for aluminum in particular) are suitable for most of the United States.

1. Temperature Change: [**120 deg F, ambient; 180 deg F, material surfaces**] <Insert temperature change>.

## 2.2 GLAZED DECORATIVE METAL RAILINGS

Retain "Basis-of-Design Product" Paragraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

- A. Basis-of-Design Product: Subject to compliance with requirements, provide **Glass Vice USA; Clearline®** or comparable product by one of the following:
- B. Source Limitations for Laminated Glass: Obtain from single source from single manufacturer.
- C. Source Limitations for Decorative Metal Railing Components: Obtain from single source from single manufacturer for each component and installation method.
- D. Product Options: Information on Drawings and in the Specifications establishes requirements for railing system's aesthetic effects and performance characteristics. 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 change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

### 2.3 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
- B. Brackets, Flanges, and Anchors: Same metal and finish as supported rails unless otherwise indicated.

### 2.4 ALUMINUM

- A. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with strength and durability properties for each aluminum form required not less than that of alloy and temper designated below.

Alloys and tempers in "Extruded Bars and Shapes, Including Extruded Tube"; "Extruded Structural Pipe and Round Tube"; "Drawn Seamless Tube"; "Plate and Sheet"; "Die and Hand Forgings"; and "Castings" paragraphs below are typical for products listed when used in railings; revise to suit structural performance requirements of railing designs indicated and to establish minimum strength properties.

For round tube railings, usually retain "Extruded Bars and Shapes, Including Extruded Tube"; "Extruded Structural Pipe and Round Tube"; and "Drawn Seamless Tube" paragraphs below if Contractor is required to design railings. For pipe railings, retain only second paragraph unless first paragraph is required for other extrusions. For square tube railings, retain only first paragraph. Primary difference between round tubing and pipe is in outside dimensions. Pipe sizes are normally indicated by use of nominal pipe size designator and weight class or schedule number; for tubing, OD and wall thickness are used. Yield strength for Alloy 6063-T5/T52 is 15 to 16 ksi (105 to 110 MPa).

- B. Extruded Bars and Shapes, Including Extruded Tube: **ASTM B221**, Alloy 6063-T5/T52.

Yield strength for Alloy 6063-T6 is 25 ksi (172 MPa).

- C. Extruded Structural Pipe and Round Tube: ASTM B429/B429M, Alloy 6063-T6.

1. Provide Standard Weight (Schedule 40) pipe unless otherwise indicated.

Yield strength for Alloy 6063-T832 is 35 to 36 ksi (240 to 250 MPa).

- D. Drawn Seamless Tubing: **ASTM B210**, Alloy 6063-T832.

Alloy 5005-H32 provides a smooth, high-quality finish and is a preferred choice for anodizing. Alloy 6061-T6 is preferred if high strength is important, but it is unsuitable for bending and does not anodize as well as Alloy 5005-H32. Yield strength for Alloy 6061-T6 is 32 to 35 ksi (220 to 240 MPa). Note that Alloy 6063 is not available in plate and sheet form.

- E. Plate and Sheet: **ASTM B209**, [**Alloy 5005-H32**] [**Alloy 6061-T6**].

- F. Die and Hand Forgings: **ASTM B247**, Alloy 6061-T6.

- G. Castings: ASTM B26/B26M, Alloy A356.0-T6.

## 2.5 STAINLESS STEEL

Retain material types, qualities, and grades in this article that are indicated in the Specifications or on Drawings. Type 304 stainless steel is usually standard; Type 316 gives better corrosion resistance in coastal environments. See the Evaluations. Grade designations "MT," "TP," and "CF" below relate to the form of metal (tubing, pipe, or castings) being specified.

Primary difference between round stainless steel tubing and stainless steel pipe is in outside dimensions. Pipe sizes are normally indicated by using nominal pipe size designator and weight class or schedule number; for tubing, OD and wall thickness are used.

- A. Tubing: ASTM A554, [**Grade MT 304**] [**Grade MT 316**].

- B. Pipe: ASTM A312/A312M, [**Grade TP 304**] [**Grade TP 316**].

Retain first option in "Castings" Paragraph below with Type 304; retain second option with Type 316 or Type 316L.

- C. Castings: ASTM A743/A743M, [**Grade CF 8 or Grade CF 20**] [**Grade CF 8M or Grade CF 3M**].

- D. Sheet, Strip, Plate, and Flat Bar: ASTM A666 or ASTM A240/A240M, [**Type 304**] [**Type 316**].

- E. Bars and Shapes: ASTM A276, [**Type 304**] [**Type 316**].

## 2.6 STEEL AND IRON

Retain this article if required for steel reinforcement and sleeves.

Usually, allow fabricator to use either type of tubing in "Tubing" Paragraph below unless structural engineer of record has designed railings.

- A. Tubing: [ASTM A500/A500M (cold formed)] [or] [ASTM A513/A513M].
- B. Bars: Hot-rolled, carbon steel complying with ASTM A29/A29M, Grade 1010.

## 2.7 COPPER ALLOYS

- A. Copper and Copper Alloys, General: Provide alloys indicated and with temper to suit application and forming methods, but with strength and stiffness not less than Temper H01 (quarter hard) for plate, sheet, strip, and bars and Temper H55 (light drawn) for tube and pipe.

Retain required forms and alloys in remaining paragraphs. In these paragraphs, the term "brass" refers to alloys that have a brassy-yellow color. The term "bronze" refers to alloys that are darker in color, similar to "architectural bronze." The term "nickel silver" refers to alloys that are silvery gold to white in color. See the Evaluations for discussion of copper alloys and colors.

Alloy UNS C38500 in "Bronze Extruded Shapes" Paragraph below is alloy most conducive to extrusion process.

- B. Bronze Extruded Shapes: ASTM B455, Alloy UNS C38500 (architectural bronze).
- C. Brass Extruded Shapes: ASTM B249/B249M, Alloy UNS C36000 (free-cutting brass).
- D. Nickel Silver Extruded Shapes: ASTM B249/B249M, Alloy UNS C79600.
- E. Bronze Seamless Pipe: ASTM B43, Alloy UNS C23000 (red brass, 85 percent copper).
- F. Bronze Seamless Tube: ASTM B135/B135M Alloy UNS C23000 (red brass, 85 percent copper).
- G. Brass Seamless Tube: ASTM B135/B135M Alloy UNS C26000 (cartridge brass, 70 percent copper).
- H. Copper Seamless Tube: ASTM B75/B75M, Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

Retain one or all three options in "Bronze Castings" Paragraph below.

- I. Bronze Castings: [Composition bronze castings complying with ASTM B62, Alloy UNS C83600 (85-5-5-5 or No. 1 composition commercial red brass)] [or] [sand castings complying with ASTM B584, Alloy UNS C86500 (No. 1 manganese bronze)].

- J. Brass Castings: Sand castings complying with ASTM B584, Alloy UNS C85200 (high-copper yellow brass).
- K. Copper Castings: ASTM B824, with a minimum of 99.9 percent copper.
- L. Nickel Silver Castings: ASTM B584, Alloy UNS C97300 (12 percent leaded nickel silver).
- M. Bronze Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C28000 (muntz metal, 60 percent copper).
- N. Brass Plate, Sheet, Strip, and Bars: ASTM B36/B36M, Alloy UNS C26000 (cartridge brass, 70 percent copper).
- O. Copper Plate, Sheet, Strip, and Bars: ASTM B152/B152M, Alloy UNS C11000 (electrolytic tough pitch copper) or Alloy UNS C12200 (phosphorous deoxidized, high-residual phosphorous copper).

## 2.8 GLASS AND GLAZING PRODUCTS, GENERAL

- A. Glazing Publications: Comply with written instructions of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

Retain publications in "NGA/GANA Publications" Subparagraph below that apply to glass products specified.

- 1. NGA/GANA Publications: [**"GANA Laminated Glazing Reference Manual" and "GANA Glazing Manual."**]
- B. Safety Glazing: Glazing is to comply with 16 CFR 1201, Category II.

Retain "Safety Glazing Labeling" Paragraph below if applicable and if labeling is required. Not all manufacturers participate in third-party testing programs.

- C. Safety Glazing Labeling: Permanently mark glass with certification label of [**the SGCC**] [**the SGCC or another certification agency acceptable to authorities having jurisdiction**] [**or**] [**manufacturer**]. Label is to indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

Retain one or more of "Clear Annealed Float Glass," "Low-Iron Float Glass," "Tinted Annealed Float Glass," "Fully Tempered Float Glass," and "Heat-Strengthened Float Glass" paragraphs below for primary float glass types because glass types in "Glass Handrails and Guards" Article depend on these primary glass standards and classifications.

- D. Clear Annealed Float Glass: ASTM C1036, Type I, Class 1 (clear), Quality-Q3.
- E. Low-Iron Float Glass: ASTM C1036, Type I, Class I (clear), Quality-Q3; and with

visible light transmission of not less than 91 percent.

- F. Tinted Annealed Float Glass: ASTM C1036, Type I, Class 2 (tinted), Quality-Q3.
- G. Fully Tempered Float Glass: ASTM C1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Class 1 and low-iron clear, or Class 2 (tinted) as indicated, Quality-Q3.
- H. Heat-Strengthened Float Glass: ASTM C1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
- I. Ceramic-Coated Glass: Heat-strengthened float glass, Condition C; with ceramic enamel applied by silk-screened process; complying with Specification No. 95-1-31 in GANA's "Engineering Standards Manual" and with other requirements specified.
- J. Bent Glass: ASTM C1464, [**Kind BFT (bent, tempered)**] [**Kind BHS, (bent, heat strengthened)**] [**Kind BL, (bent, laminated)**].

Glazing cement is limited to tempered glass installations. Glazing cement can accelerate laminated glass delamination and may be susceptible to moisture and thermal movement in exterior applications.

- K. Glazing Cement and Accessories for Structural Glass Railings: Glazing cement, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.

Compatible sealants are required for structural laminated glass railings. Consult manufacturers of glazed railings for approved sealants.

- L. Sealant and Accessories for Structural Glass Railings: Sealant, gaskets, setting blocks, shims, and related accessories as recommended or supplied by railing manufacturer for installing structural glazing in metal base channels.

Retain "Glazing Gaskets for Glass-Infill Panels" Paragraph below only for post-supported railings with glass-infill panels.

- M. Glazing Gaskets for Glass-Infill Panels: Glazing gaskets and related accessories as recommended or supplied by railing manufacturer for installing glass-infill panels in post-supported railings.

## 2.9 GLASS HANDRAILS AND GUARDS

- A. Tempered Glass Handrails and Guards: Provide products that have been tested for surface and edge compression in accordance with ASTM C1048 and for impact strength in accordance with 16 CFR 1201 for Category II materials.

- 1. Glass Color: [**Clear**] [**Blue**] [**Blue-green**] [**Bronze**] [**Green**] [**Gray**] <Insert color>.

Retain one or more thickness requirements in "Thickness for Structural Glass Balusters," "Thickness for Glass-Infill Panels," and "Glass Thickness" subparagraphs below. Tinted glass is not available in thicknesses more than 12 mm. Verify thickness by structural analysis. Verify, with railing manufacturers, availability of glass thicknesses. The IBC limits locations of non-laminated, single-pane (monolithic) tempered glass in handrails or guards.

2. Thickness for Structural Glass Balusters: As required by structural loads, but not less than **[12.0] [19.0]** mm.
  3. Thickness for Glass-Infill Panels: As required by structural loads, but not less than **[6.0] [10.0]** mm.
  4. Glass Thickness: As indicated on Drawings.
- B. Laminated Glass Handrails and Guards: ASTM C1172, Type II with two plies of glass bonded together by an interlayer.
1. Construction: Laminate glass with **[polyvinyl butyral interlayer] [or] [ionoplast polymer interlayer]** to comply with interlayer manufacturer's written instructions.
  2. Interlayer Thickness: **[0.030 inch] [0.060 inch] [0.090 inch]**.

Retain one of first two options in "Kind" Subparagraph below or retain "As indicated" option and indicate kinds required in "Fabrication of Glass Panels and Balusters" Article.

3. Kind: **[LHS (laminated heat strengthened)] [LT (laminated tempered)] [As indicated]**.
4. Glass Color: Inner-ply **[clear] [low-iron clear] [blue] [blue-green] [bronze] [green] [gray] <Insert color>**; outer-ply **[clear] [low-iron clear] [blue] [blue-green] [bronze] [green] [gray] <Insert color>**.
5. Ceramic Coating Color and Pattern: **[As selected by Architect from manufacturer's full range] <Insert manufacturer's color and pattern designation>**, applied to **[inner] [outer]** glass ply.
6. Interlayer Color: **[Clear] [Blue-green] [Bronze light] [Gray] <Insert color>**.

Retain "Interlayer Color and Pattern" Subparagraph below for interlayer with printed decorative pattern.

7. Interlayer Color and Pattern: **[As selected by Architect from manufacturer's full range] [Match] [Provide] <Insert manufacturer's color and pattern designation>**.

Retain one or more thickness requirements in "Glass Plies for Structural Glass Balusters" and "Glass Plies for Glass-Infill Panels" subparagraphs below. Verify thickness by structural analysis. Verify, with railing manufacturers, availability of glass thicknesses.

8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than **[6.0] [8.0]** mm thick each.
9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than **[3.0] [4.0] [5.0]** mm each.

Retain "Windborne-Debris-Impact-Resistant Laminated Glass Guards" Paragraph below if retaining "Windborne-Debris-Impact Resistance" Paragraph in "Performance Requirements" Article.

- C. Windborne-Debris-Impact-Resistant Laminated Glass Guards: ASTM C1172, Type II with two plies of glass bonded together with an interlayer.

1. Construction: Laminate glass with **[polyvinyl butyral interlayer]** **[or]** **[ionoplast polymer interlayer]** to comply with interlayer manufacturer's written instructions.
2. Interlayer Thickness: **[0.060 inch]** **[0.090 inch]**.

Retain one of first two options in "Kind" Subparagraph below or retain "As indicated" option and indicate kinds required in "Fabrication of Glass Panels and Balusters" Article.

3. Kind: **[LHS (laminated heat strengthened)]** **[LT (laminated tempered)]** **[As indicated]**.
4. Glass Color: Inner-ply **[clear]** **[low-iron clear]** **[blue]** **[blue-green]** **[bronze]** **[green]** **[gray]** **<Insert color>**; outer-ply **[clear]** **[low-iron clear]** **[blue]** **[blue-green]** **[bronze]** **[green]** **[gray]** **<Insert color>**.
5. Ceramic Coating Color and Pattern: **[As selected by Architect from manufacturer's full range]** **<Insert manufacturer's color and pattern designation>**, applied to **[inner]** **[outer]** glass ply.
6. Interlayer Color: **[Clear]** **[Blue-green]** **[Bronze light]** **[Gray]** **<Insert color>**.

Retain "Interlayer Color and Pattern" Subparagraph below for interlayer with printed decorative pattern.

7. Interlayer Color and Pattern: **[As selected by Architect from manufacturer's full range]** **[Match]** **[Provide]** **<Insert manufacturer's color and pattern designation>**.

Retain one or more thickness requirements in "Glass Plies for Structural Glass Balusters" and "Glass Plies for Glass-Infill Panels" subparagraphs below. Verify thickness by structural analysis. Verify, with railing manufacturers, availability of glass thicknesses.

8. Glass Plies for Structural Glass Balusters: Thickness required by structural loads, but not less than **[6.0]** **[8.0]** **[10]** mm thick each.
9. Glass Plies for Glass-Infill Panels: Thickness required by structural loads, but not less than **[4.0]** **[5.0]** mm each.

## 2.10 FASTENERS

- A. Fastener Materials: Unless otherwise indicated, provide the following:

Retain or revise applicable requirements in "Aluminum Components," "Stainless Steel Components," "Copper-Alloy (Bronze) Components," "Copper-Alloy (Brass) Components," and "Dissimilar Metals" subparagraphs below.

1. Aluminum Components: **[Type 304]** **[Type 316]** stainless steel fasteners.
2. Stainless Steel Components: **[Type 304]** **[Type 316]** stainless steel fasteners.

Delete option in "Copper-Alloy (Bronze) Components" and "Copper-Alloy (Brass) Components" subparagraphs below if color match is not critical or if exposed fasteners are not allowed. Silicon bronze fasteners are more commonly available than fasteners of other alloys.

3. Copper-Alloy (Bronze) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners **[where concealed; muntz metal (Alloy 280) fasteners where exposed]**.
4. Copper-Alloy (Brass) Components: Silicon bronze (Alloy 651 or Alloy 655) fasteners **[where concealed; brass (Alloy 260 or Alloy 360) fasteners where**

**exposed**].

5. Dissimilar Metals: **[Type 304]** **[Type 316]** stainless steel fasteners.
- B. Fasteners for Anchoring to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated **[ and capable of withstanding design loads]**.
- C. Provide concealed fasteners for interconnecting railing components and for attaching railings to other work unless **[otherwise indicated]** **[exposed fasteners are unavoidable]** **[exposed fasteners are the standard fastening method for railings indicated]**.

Revise subparagraph below if another type of head is required or is standard with system specified.

1. Provide **[Phillips]** **[tamper-resistant]** **[square or hex socket]** flat-head machine screws for exposed fasteners unless otherwise indicated.

ICC-ES AC193 is for mechanical anchors; ICC-ES AC308 is for adhesive anchors.

- D. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to design load, in accordance with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC193 **[ or ICC-ES AC308]**.

Material in "Material for Interior Locations" Subparagraph below protects against corrosion in an indoor atmosphere.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B633 or ASTM F1941/ASTM F1941M, Class Fe/Zn 5, unless otherwise indicated.

First option in "Material for Exterior Locations and Where Stainless Steel Is Indicated" Subparagraph below refers to Type 304 and similar alloys; second option refers to Type 316 and similar alloys.

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy **[Group 1]** **[Group 2]** stainless steel bolts, ASTM F593, and nuts; **ASTM F594**.

## 2.11 MISCELLANEOUS MATERIALS

- A. Handrail Brackets: **[Cast aluminum,]** **[Cast stainless steel,]** **[Cast bronze,]** **[Cast brass,]** **[Cast copper,]** **[Cast nickel-silver,]** center of rail **[2-1/2 inches]** **[3-1/8 inches]** **<Insert dimension>** from face of structural glass balusters.
- B. Wood Rails:

Retain one of first two subparagraphs below. Retain first if wood rails are supplied by railing manufacturer; retain second if they are supplied by architectural woodworker.

1. Clear, straight-grained hardwood rails secured to **[recessed]** **[exposed]** metal

subrail.

"Species," "Finish," "Staining," and "Profile" subparagraphs below are examples only.

- a. Species: [Ash] [Cherry] [Red oak] [Walnut] [White oak] <Insert species>.
- b. Finish: [Manufacturer's standard] [Transparent polyurethane] [Penetrating oil] [Acrylic impregnated].
- c. Staining: [None] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert description or manufacturer's name and product designation>.

If rails are required to serve as handrails rather than only as top rails of guards, verify that profile specified will comply with applicable regulations for accessibility to people with disabilities.

- d. Profile: [Square, 1-3/4 by 1-3/4 inches with edges eased to 1/4-inch radius] [Rectangular, 1-3/4 by 5 inches with edges eased to 1/4-inch radius] [Round, 2-inch diameter] [As indicated] <Insert description>.
2. Hardwood rails complying with Section 064023 "Interior Architectural Woodwork."

"Certified Wood" Subparagraph below applies to LEED 2009. Manufacturers certifying products as "FSC Mixed Credit" do not have to use 100 percent certified wood in the products; however, in their total production, manufacturers must use an amount equal to or greater than the percentage of their production that is labeled "FSC Mixed Credit."

3. Certified Wood: Wood products shall be certified as "FSC Pure"[ or "FSC Mixed Credit"] according to FSC STD-01-001 and FSC STD-40-004.

"Certified Wood" Subparagraph below applies to LEED v4. Manufacturers certifying products as "FSC Mixed Credit" do not have to use 100 percent certified wood in the products; however, in their total production, manufacturers must use an amount equal to or greater than the percentage of their production that is labeled "FSC Mixed Credit."

4. Certified Wood: Wood products shall be certified as "FSC Pure"[ or "FSC Mixed Credit"] according to FSC STD-01-001 and FSC STD-40-004.

"Certified Wood" Subparagraph below applies to IgCC.

5. Certified Wood: Wood products shall be labeled according to the AF&PA's Sustainable Forestry Initiative, be certified as "FSC Pure" according to FSC STD-01-001 and FSC STD-40-004, or be certified and labeled according to the standards of the Programme for Endorsement of Forest Certification.

"Certified Wood" Subparagraph below applies to ASHRAE 189.1.

6. Certified Wood: Wood products shall [contain not less than 60 percent] [be made from] certified wood tracked through a chain-of-custody process. Certified wood documentation shall be provided by sources certified through a forest certification system with principles, criteria, and standards developed using ISO/IEC Guide 59 or the World Trade Organization's "WTO Agreement on Technical Barriers to Trade."

"Certified Wood" Subparagraph below applies to Green Globes.

7. Certified Wood: Wood products shall be certified according to the American Tree

Farm System's "AFF Standard," the AF&PA's Sustainable Forestry Initiative, FSC STD-01-001 and FSC STD-40-004, or the standards of the Programme for Endorsement of Forest Certification.

Retain "Lacquer for Copper Alloys" Paragraph below if any lacquered copper-alloy finishes are required.

- C. Lacquer for Copper Alloys: Clear acrylic lacquer specially developed for coating copper-alloy products.
- D. Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

Retain "Nonshrink, Nonmetallic Grout" or "Anchoring Cement" Paragraph below, or both, to suit Project.

- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
  - 1. Water-Resistant Anchoring Cement: **[At exterior locations] [and] [where indicated]** provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

## 2.12 FABRICATION OF METAL RAILINGS

- A. Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage[, **but not less than that required to support structural loads**].
- B. Assemble railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately **1/32 inch** unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.

- E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate. Locate weep holes in inconspicuous locations.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Mechanical Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
  - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- H. Form changes in direction as follows:

Retain one of five subparagraphs below. Second subparagraph allows fabricator to choose radius of bends. Third is for flush (zero-radius) bends. Fourth is for radii that are indicated on Drawings.

- 1. As detailed.
- 2. **[By bending] [or] [by inserting prefabricated elbow fittings].**
- 3. **[By flush bends] [or] [by inserting prefabricated flush-elbow fittings].**
- 4. **[By radius bends of radius indicated] [or] [by inserting prefabricated elbow fittings of radius indicated].**
- 5. By bending to smallest radius that will not result in distortion of railing member.

Retain first paragraph below if bending is allowed or required.

- I. Bend members in jigs to produce uniform curvature for each configuration required; maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- J. Close exposed ends of hollow railing members with prefabricated end fittings.
- K. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, handrail brackets, miscellaneous fittings, and anchors to interconnect railing members to other work where indicated.

Retain subparagraph below if any railings are supported from plaster or gypsum board walls.

- 1. At brackets and fittings fastened to plaster or gypsum board partitions, provide crush-resistant fillers, or other means to transfer loads through wall finishes to structural supports and to prevent bracket or fitting rotation and crushing of substrate.
- L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

Delete paragraph below if no posts are set in concrete or if posts are set without sleeves.

- M. For railing posts set in concrete, provide **[steel] [stainless steel]** sleeves not less than **6 inches** long with inside dimensions not less than **1/2 inch** greater than outside dimensions of post, with metal plate forming bottom closure.

#### 2.13 FABRICATION OF GLASS PANELS AND BALUSTERS

- A. Fabricate glass to sizes and shapes required; provide for proper edge clearance and bite on glazing panels.
- B. Glass-Infill Panels: Provide **[tempered] [laminated, heat-strengthened] [laminated, tempered]** glass-infill panels **[ for both straight and curved sections]**.

Revise edging descriptions in "Edge Finish" Subparagraph below to suit Project.

- 1. Edge Finish: **[Clean-cut or flat-grind edges to produce smooth, square edges with slight chamfers at junctions of edges and faces] <Insert edge finishes>**.
- C. Structural Glass Balusters: Provide **[tempered] [laminated, heat-strengthened] [laminated, tempered]** structural glass balusters **[ for both straight and curved sections]**.

Revise edging description in "Edge Finish" Subparagraph below to suit Project.

- 1. Edge Finish: **[Grind smooth and flat polish exposed edges of glass, including those at open joints, to produce smooth, square edges with glass edge finishes]**.

Factory-bonded method in first subparagraph below is standard with some manufacturers and optional with others. Many offer only field-glazed systems. Coordinate with manufacturers.

- 2. Factory-bond structural glass balusters to aluminum base and top-rail channels in railing manufacturer's plant using **[glazing cement] [sealant]** to comply with manufacturer's written instructions, **unless field glazing is standard with manufacturer]**.
- 3. Fabricate structural glass balusters to maintain equal length glass widths and uniform spacing of **[1/2 inch] <Insert spacing>** between glass balusters.

#### 2.14 METAL FINISH REQUIREMENTS, GENERAL

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipment.

Retain "Appearance of Finished Work" Paragraph below for variable finishes, such as anodized or patina finishes.

- B. 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.

Retain paragraph below if exposed fasteners are allowed, especially with color anodic finish.

- C. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

## 2.15 ALUMINUM FINISHES

Retain or revise finishes in this article to suit Project. If retaining more than one finish in paragraphs below, indicate location of each on Drawings or by inserts. Revise mechanical finish if custom finish is required and availability is verified.

- A. Mechanical Finish: AA-M3x; sand top rails, handrails, and intermediate rails in one direction only, parallel to length of railing, with 120- and 320-grit abrasive. After installation, polish railings with No. 0 steel wool immersed in paste wax, then rub to a luster with a soft dry cloth.

Retain one of two options in "Clear Anodic Finish" Paragraph below. Verify availability with manufacturers.

- B. Clear Anodic Finish: AAMA 611, [**AA-M12C22A41, Class I, 0.018 mm**] [**AA-M12C22A31, Class II, 0.010 mm**] or thicker.

Retain one of two options in "Color Anodic Finish" Paragraph below. Verify availability with manufacturers.

- C. Color Anodic Finish: AAMA 611, [**AA-M12C22A42/A44, Class I, 0.018 mm**] [**AA-M12C22A32/A34, Class II, 0.010 mm**] or thicker.

Options in "Color" Subparagraph below are examples only and may vary in color range and availability among manufacturers.

- 1. Color: [**Champagne**] [**Light bronze**] [**Medium bronze**] [**Dark bronze**] [**Black**] [**Match Architect's sample**] [**As selected by Architect from full range of industry colors and color densities**] <Insert color>.

"Baked-Enamel or Powder-Coat Finish" Paragraph below references AAMA standard for pigmented organic coating on extrusions and panels.

- D. Baked-Enamel or Powder-Coat Finish: AAMA 2603 except with a minimum dry film thickness of **1.5 mils**. Comply with coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
  - 1. Color and Gloss: [**As indicated by manufacturer's designations**] [**Match Architect's sample**] [**As selected by Architect from manufacturer's full range**] <Insert color and gloss>.

- E. Siliconized Polyester Finish: Epoxy primer and silicone-modified, polyester-enamel topcoat; with a dry film thickness of not less than **0.2 mil** for primer and **0.8 mil** for topcoat.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.

Retain "High-Performance Organic Finish, Two-Coat PVDF"; "Superior-Performing Organic Finish, Three-Coat PVDF"; "Superior-Performing Organic Finish, Four-Coat PVDF"; "Superior-Performing Organic Finish, Single-Coat FEVE"; or "Superior-Performing Organic Finish, Two-Coat FEVE" Paragraph below. If more than one is required, indicate location of each system on Drawings, in schedules, or by inserts. If specific products are required, name coating manufacturers and products.

In "High-Performance Organic Finish, Two-Coat PVDF" Paragraph below, retain AAMA 2604 with 50 percent resin content by weight in color coat or AAMA 2605 with 70 percent resin content by weight in color coat for high-performance organic coatings on extrusions and panels.

- F. High-Performance Organic Finish, Two-Coat PVDF: Fluoropolymer finish complying with **[AAMA 2604] [AAMA 2605]** and containing not less than **[50] [70]** percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[ for seacoast and severe environments]**.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- G. Superior-Performing Organic Finish, Three-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[ for seacoast and severe environments]**.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- H. Superior-Performing Organic Finish, Four-Coat PVDF: Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent PVDF resin by weight in both color coat and clear topcoat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions **[ for seacoast and severe environments]**.
1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.

"Superior-Performing Organic Finish, Single-Coat FEVE" Paragraph below is unsuitable for

seacoast and severe environments.

- I. Superior-Performing Organic Finish, Single-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
  1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.
- J. Superior-Performing Organic Finish, Two-Coat FEVE: Fluoropolymer finish complying with AAMA 2605. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions for seacoast and severe environments.
  1. Color and Gloss: **[As indicated by manufacturer's designations] [Match Architect's sample] [As selected by Architect from manufacturer's full range] <Insert color and gloss>**.

2.16 STAINLESS STEEL FINISHES

- A. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
- B. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

Retain first subparagraph below for directional finishes.

1. Run grain of directional finishes with long dimension of each piece.
  2. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.
- C. Stainless Steel Tubing Finishes:

Retain "180-Grit Polished Finish," "320-Grit Polished Finish," or "Polished and Buffed Finish" Subparagraph below. Coordinate with other Sections that include stainless steel railings to ensure uniform finish throughout Project, if desired, because finishes between manufacturers seldom match. Insert other finishes as required after verifying availability with manufacturers. See the Evaluations.

180-grit polished finish is the most common finish for handrail tubing.

1. 180-Grit Polished Finish: Uniform, directionally textured finish.

320-grit polished finish has a finer texture than 180-grit finish.

2. 320-Grit Polished Finish: Oil-ground, uniform, fine, directionally textured finish.

Polished and buffed finish is similar to ASTM A480/A480M, No. 7 finish for sheet and plate.

3. Polished and Buffed Finish: 320-grit finish followed by buffing **[to a high luster]**

**finish] [to a mirrorlike finish] [to match Architect's sample].**

D. Stainless Steel Sheet, Strip, Plate, and Bar Finishes:

Retain "Directional Satin Finish," "High Luster Finish," or "Mirror Finish" Subparagraph below. Insert others as required after verifying availability with manufacturers. See the Evaluations.

No. 4 finish is equivalent to a 120- to 180-grit polished finish.

1. Directional Satin Finish: ASTM A480/A480M, No. 4.

No. 7 finish has a high degree of reflectivity, produced by buffing a finely ground finish, but the grit lines are not removed.

2. High Luster Finish: ASTM A480/A480M, No. 7.

No. 8 finish is highly reflective, smooth polished up to a 320-grit, and then buffed to a mirrorlike finish.

3. Mirror Finish: ASTM A480/A480M, No. 8.

## 2.17 COPPER-ALLOY FINISHES

A. Finish designations for copper alloys comply with the system for designating copper-alloy finish systems defined in NAAMM/NOMMA 500, "Metal Finishes Manual for Architectural and Metal Products."

Retain or revise finishes in this article to suit Project. If retaining more than one finish in paragraphs below, indicate location of each on Drawings or by inserts. Revise mechanical finish if custom finish is required and availability is verified.

Retain one or more of "Buffed Finish," "Hand-Rubbed Finish," "Medium-Satin Finish," and "Fine-Matte Finish" paragraphs below for mechanical finishes without lacquer.

- B. Buffed Finish: M21 (Mechanical Finish: buffed, smooth specular).
- C. Hand-Rubbed Finish: M31-M34 (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed).
- D. Medium-Satin Finish: M32 (Mechanical Finish: directionally textured, medium satin).
- E. Fine-Matte Finish: M42 (Mechanical Finish: nondirectional finish, fine matte).

Retain one or more of "Lacquered Buffed Finish," "Lacquered Hand-Rubbed Finish," "Lacquered Medium-Satin Finish," and "Lacquered Fine-Matte Finish" paragraphs below for lacquered mechanical finishes.

F. Lacquered Buffed Finish: M21-O6x (Mechanical Finish: buffed, smooth specular; Coating: clear, organic, air dried, as specified below).

1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray

in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil**.

- G. Lacquered Hand-Rubbed Finish: M31-M34-O6x (Mechanical Finish: directionally textured, fine satin; Mechanical Finish: directionally textured, hand rubbed; Coating: clear, organic, air dried, as specified below).
  - 1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil**.
- H. Lacquered Medium-Satin Finish: M32-O6x (Mechanical Finish: directionally textured, medium satin; Coating: clear, organic, air dried, as specified below).
  - 1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil**.
- I. Lacquered Fine-Matte Finish: M42-O6x (Mechanical Finish: nondirectional finish, fine matte; Coating: clear, organic, air dried, as specified below).
  - 1. Clear, Organic Coating: Lacquer specified for copper alloys, applied by air spray in two coats per manufacturer's written instructions, with interim drying, to a total thickness of **1 mil**.

Finish in "Statuary Conversion Coating over Satin Finish" Paragraph below is used only with bronze.

- J. Statuary Conversion Coating over Satin Finish: M31-C55 (Mechanical Finish: directionally textured, fine satin; Chemical Finish: conversion coating, sulfide).

"Color" Subparagraph below is preferred method of specifying because of variations in color.

- 1. Color: Match Architect's sample.
- K. Patina Conversion Coating: M36-C12-C52 (Mechanical Finish: directionally textured, uniform; Chemical Finish: nonetched cleaned, degreased; Chemical Finish: conversion coating, ammonium sulfate)[, **with color matching Architect's sample**].

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Comply with Drawings and manufacturer's written instructions for installing glazed decorative metal railings, accessories, and other components.

Retain "Windborne-Debris Resistance" Paragraph below for exterior installations requiring windborne-debris resistance. Proper anchorage of railings is necessary to maintain performance

as tested.

- B. Windborne-Debris Resistance: Anchor glazed decorative metal railings to structure using anchoring method, fastener type, and fastening frequency identical to that used in windborne-debris-resistance testing.
- C. Perform cutting, drilling, and fitting required for installing metal railings.
  - 1. Fit exposed connections together to form tight, hairline joints.
  - 2. Install railings level, plumb, square, true to line; without distortion, warp, or rack.
  - 3. Set railings accurately in location, alignment, and elevation; measured from established lines and levels.
  - 4. Do not weld, cut, or abrade surfaces of metal railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.

Revise two subparagraphs below if closer tolerances are required. Both are from NAAMM's "Pipe Railing Systems Manual."

- 5. Set posts plumb within a tolerance of **1/16 inch in 3 feet**.
  - 6. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed **1/4 inch in 12 feet**.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
  - 1. Coat concealed surfaces of **[aluminum] [and] [copper alloys]** that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with **[shop primer] [bituminous paint]**.
- E. Adjust railings before anchoring to ensure matching alignment at abutting joints.
- F. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

### 3.2 METAL RAILING CONNECTIONS

- A. Nonwelded Connections:
  - 1. Use mechanical or adhesive joints for permanently connecting railing components.
  - 2. Use wood blocks and padding to prevent damage to railing members and fittings.
  - 3. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

Retain "Expansion Joints" Paragraph below if expansion joints are required or revise to suit Project. Indicate locations on Drawings based on temperature changes expected and coefficient of expansion of metals involved.

- B. Expansion Joints: Install expansion joints at locations indicated, but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending **2 inches** beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within **6 inches** of post.

### 3.3 METAL ANCHORING POSTS

Retain type(s) of anchorage in this article to suit Project.

Retain one of first two paragraphs below, or delete both if no posts in concrete. Coordinate with products specified in Part 2.

- A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted in sleeves, fill annular space between post and sleeve with **[nonshrink, nonmetallic grout] [or] [anchoring cement]**, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than **5 inches** deep and **3/4 inch** larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with **[nonshrink, nonmetallic grout] [or] [anchoring cement]**, mixed and placed to comply with anchoring material manufacturer's written instructions.

Retain one of first two paragraphs below if retaining either concrete anchorage method above.

- C. Cover anchorage joint with flange of same metal as post, **[welded to post after placing anchoring material] [attached to post with setscrews]**.
- D. Leave anchorage joint exposed with **[1/8-inch buildup, sloped away from post] [anchoring material flush with adjacent surface]**.

Revise first paragraph below if posts are welded directly to supports.

- E. Anchor posts to metal surfaces with flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:

Retain one of three subparagraphs below. Welded and bolted connections of aluminum and copper alloys should be specially detailed.

1. For aluminum railings, attach posts as indicated using fittings designed and engineered for this purpose.
2. For copper-alloy railings, attach posts as indicated using fittings designed and engineered for this purpose.
3. For stainless steel railings, weld flanges to posts and bolt to metal-supporting surfaces.

Retain paragraph below if applicable.

- F. Install removable railing sections, where indicated, in slip-fit metal sockets cast in

concrete.

### 3.4 INSTALLATION OF GLASS BALUSTERS

#### A. Structural Glass Railings:

1. Install assembly to comply with railing manufacturer's written instructions.
2. Attach base channel to building structure, then insert and connect factory-fabricated and -assembled glass balusters[ **if glass was bonded to base and top-rail channels in factory**].

Delete first subparagraph below and option in subparagraph above if only factory-assembled panels are allowed.

3. For field-assembled balusters, attach base channel to building structure, insert glass in base channel, and bond with **[glazing cement] [sealant]**.
  - a. Support glass balusters in base channel at quarter points with channel-shaped setting blocks that also act as shims to maintain uniform space for glazing cement.
  - b. Fill remaining space in base channel with **[glazing cement] [sealant]** for uniform support of glass.
4. Adjust spacing of glass balusters so gaps between balusters are equal before securing in position.

Before retaining subparagraph below, verify availability of authorized personnel with manufacturers.

5. Erect glass railings under direct supervision of manufacturer's authorized technical personnel.

For post-supported railings with glass-infill panels, retain "Post-Supported Railings with Glass-Infill Panels" Paragraph below and requirements in other Part 3 articles that apply to type of railing construction used.

#### B. Post-Supported Railings with Glass-Infill Panels:

1. Install assembly to comply with railing manufacturer's written instructions and with requirements in other Part 3 articles.
2. Erect posts and other metal railing components, and set factory-cut glass-infill panels.
3. Do not cut, drill, or alter glass-infill panels in field. Protect edges from damage.

### 3.5 FIELD QUALITY CONTROL

Retain this article if field testing for compliance with performance requirements is required in addition to product test reports and preconstruction testing.

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and

inspections and to prepare test reports. Payment for these services will be made [by **Owner**] [from the testing and inspecting allowance, as authorized by Change Orders].

Revise "Extent and Testing Methodology" Paragraph below if more extensive testing is required.

- B. Extent and Testing Methodology: Testing agency will randomly select completed railing assemblies for testing that are representative of different railing designs and conditions in the completed Work. Test railings in accordance with ASTM E894, ASTM E935, ASTM E2353, and ASTM E2358 for compliance with performance requirements.
- C. Remove and replace railings where test results indicate that they do not comply with specified requirements unless they can be repaired in a manner satisfactory to Architect and comply with specified requirements.
- D. Perform additional testing and inspecting, at Contractor's expense, to determine compliance of replaced or additional work with specified requirements.

### 3.6 CLEANING

- A. Clean aluminum and stainless steel by washing thoroughly with water and soap, rinsing with clean water, and wiping dry.

Revise first paragraph below to indicate specific cleaning technique to suit type of finish specified.

- B. Clean copper alloys in accordance with metal finisher's written instructions in a manner that leaves an undamaged and uniform finish matching approved Sample.
- C. Clean and polish glass as recommended in writing by manufacturer. Wash both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion.
- D. Clean wood rails by wiping with a damp cloth and then wiping dry.

### 3.7 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.
- B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION 057313