SECTION 055213 - PIPE AND TUBE RAILINGS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			2. SUMMARY
				1. Section Includes:

Steel railings.

Aluminum railings.

Stainless steel railings.

* + - 1. COORDINATION
				1. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
				2. 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 such items to Project site in time for installation.
			2. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data:

Manufacturer's product lines of mechanically connected railings.

Expanded metal infill panels.

Perforated metal infill panels.

Woven-wire mesh infill panels.

Fasteners.

Post-installed anchors.

Handrail brackets.

Shop primer.

Intermediate coats and topcoats.

Bituminous paint.

Nonshrink, nonmetallic grout.

Anchoring cement.

Metal finishes.

Paint products.

* + - * 1. Sustainable Design Submittals:
				2. Shop Drawings: Include plans, elevations, sections, details, attachments to other work, and welding procedure specifications (WPS).

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

* + - * 1. Samples for Initial Selection: For products involving selection of color, texture, or design**[, including mechanical finishes]**.
				2. Samples for Verification: For each type of exposed finish required.

Sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters, including finish.

Fittings and brackets.

Assembled Sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Sample need not be full height.

Show method of **[connecting] [and] [finishing]** members at intersections.

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

* + - * 1. Delegated-Design Submittal: For railings, including analysis and design data signed and sealed by the qualified professional engineer, licensed in the State of New York, responsible for their preparation.

Coordinate "Qualification Data" Paragraph below with qualification requirements in "Quality Assurance" Article.

* + - * 1. Qualification Data: For professional engineer’s experience with providing delegated-design engineering services of the kind indicated, including documentation that engineer is licensed and registered in the State of New York

Retain "Welding certificates" Paragraph below if retaining "Welding Qualifications" Paragraph in "Quality Assurance" Article.

* + - * 1. Welding certificates.

Retain "Mill Certificates" Paragraph below if increased corrosion resistance of Type 316 stainless steel is required.

* + - * 1. Mill Certificates: Signed by manufacturers of stainless steel products, certifying that products furnished comply with requirements.

Consider retaining "Paint Compatibility Certificates" Paragraph below if primers are fully specified in this Section rather than in painting Sections.

* + - * 1. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.

"Product Test Reports" Paragraph below may be used for verification of performance requirements if authorities having jurisdiction do not allow Contractor to provide engineering calculations.

Design Consultant to review code references and verify that the referenced sections/tables are current. Note that code references shall be based on the current version of the Uniform Code.

* + - * 1. Product Test Reports: For tests on railings performed by a qualified testing agency, in accordance with ASTM E894 and ASTM E935.
				2. Research Reports: For post-installed anchors, from ICC-ES or other qualified testing agency acceptable to authorities having jurisdiction.

Retain "Source quality-control reports" Paragraph below if Contractor is responsible for source quality-control testing and inspecting.

* + - * 1. Source quality-control reports.

Use subparagraph below for projects over $100,000. See Article 1.4. below.

Documentation to confirm compliance.

* + - 1. QUALITY ASSURANCE

Retain "Welding Qualifications" Paragraph below if shop or field welding is required. If retaining, also retain "Welding certificates" Paragraph in "Informational Submittals" Article.

* + - * 1. Welding Qualifications: Qualify procedures and personnel in accordance with the following:

AWS D1.1, "Structural Welding Code - Steel."

AWS D1.2, "Structural Welding Code - Aluminum."

AWS D1.6, "Structural Welding Code - Stainless Steel."

Use paragraph below for projects over $100,000. Paragraph is taken from Article 25.4 of the General Conditions.

* + - * 1. If the value of the contract exceeds $100,000 all structural steel, reinforcing steel and other major steel items to be incorporated in the Work of this Contract shall be produced and made in whole or substantial part in the United States, its territories or possessions.
			1. DELIVERY, STORAGE, AND HANDLING
				1. Protect mechanical finishes on exposed surfaces of railings from damage by applying a strippable, temporary protective covering before shipping.
			2. FIELD CONDITIONS

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

* + - * 1. Field Measurements: Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication.

Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers.

Protect steel members and packaged materials from corrosion and deterioration.

Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures.

Repair or replace damaged materials or structures as directed.

* + - * 1. Store and handle galvanized steel members per the recommendations of the American Galvanized Association.
1. PRODUCTS

Manufacturers and products listed in SpecAgent and MasterWorks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications

* + - 1. PERFORMANCE REQUIREMENTS

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

* + - * 1. Delegated Design: Engage a qualified professional engineer, licensed and registered to practice in the State of New York, to design railings, including attachment to building construction.
				2. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

Subparagraphs below are based on the NYSBC; revise to suit Project and to comply with requirements of authorities having jurisdiction.

Handrails and Top Rails of Guards:

Uniform load of 50 lbf/ ft. applied in any direction.

Concentrated load of 200 lbf applied in any direction.

Uniform and concentrated loads need not be assumed to act concurrently.

Infill of Guards:

Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft..

Infill load and other loads need not be assumed to act concurrently.

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

* + - * 1. 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.

Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

* + - 1. METALS, GENERAL
				1. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.
				2. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails unless otherwise indicated.

Provide type of bracket with **[flange tapped for concealed anchorage to threaded hanger bolt] [predrilled hole for exposed bolt anchorage]** and that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.

* + - 1. STEEL RAILINGS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Hollaender Mfg. Co.

Kee Safety, Inc.

VIVA Railings, LLC.

Approved equivalent.

Steel pipe railings are generally fabricated by local ironworks. If listing manufacturers from Paragraph Builder, consider adding names of local fabricators to list.

* + - * 1. Source Limitations: Obtain each type of railing from single source from single manufacturer.

Retain applicable material types, qualities, and grades from paragraphs below.

Usually allow fabricator to use either type of tubing in "Tubing" Paragraph below unless structural engineer of record has designed railings. If higher strength is required, consider specifying ASTM A513, Type 5 tubing or perhaps ASTM A513 tubing of a high-strength alloy, after verifying availability.

* + - * 1. Tubing: **[ASTM A500 (cold formed)] [or] [ASTM A513, Type 5]**.

Primary difference between round steel tubing and steel pipe is in outside dimensions. Pipe sizes are normally indicated by use of NPS designator and weight class or schedule number; for tubing, OD and wall thickness are used. See the Evaluations.

Type, grade, and weight in "Pipe" Paragraph below are typical default requirements; revise to suit Project.

* + - * 1. Pipe: ASTM A53, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

Delete subparagraph below if railings are galvanized after fabrication or if not using galvanized railings.

Provide galvanized finish for exterior installations and where indicated.

* + - * 1. Plates, Shapes, and Bars: ASTM A36.
				2. Cast Iron Fittings: Either gray iron, ASTM A48, or malleable iron, ASTM A47, unless otherwise indicated.
				3. Expanded Metal Infill Panels: ASTM F1267, **[Type I (expanded)] [Type II (expanded and flattened)]**, Class 1 (uncoated).

Designations in "Style Designation" Subparagraph below indicate size. 3/4 number 13 has openings approximately 3/4 by 1-1/2 inches and is 0.09 to 0.10 inch thick; 1-1/2 number 10 has openings approximately 1 by 2-1/2 inches and is 0.13 to 0.142 inch thick.

Style Designation: **[3/4 number 13] [1-1/2 number 10]**.

* + - * 1. Perforated-Metal Infill Panels:

Cold-Rolled Steel Sheet: ASTM A1008, or hot-rolled steel sheet, ASTM A1011, commercial steel, Type B, **[0.060 inch] <Insert dimension>** thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows]**.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product.

Basis-of-Design Product: Provide product with perforations matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.

Galvanized-Steel Sheet, ASTM A653, G90 coating, commercial steel Type B, **[0.064 inch] <Insert dimension>** thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows] [with 1/8-by-1-inch round end slotted holes in staggered rows]**.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product.

Basis-of-Design Product: Provide product with perforations matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.

* + - * 1. Woven-Wire Mesh Infill Panels: Intermediate-crimp, **[diamond] [square]** pattern, 2-inch woven-wire mesh, made from 0.134-inch- diameter steel wire complying with ASTM A510.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product.

Basis-of-Design Product: Provide product with crimp pattern matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.

Use the Article below for DOCCS projects where there is inmate contact.

* + - * 1. Welded-Wire Mesh: Intermediate-crimp or lock-crimp as indicated, Square pattern, 2-inch welded-wire mesh, made from 0.375-inch nominal-diameter steel wire complying with ASTM A510.

Use the Article below for DOCCS projects where non-climbing mesh is required and there is inmate contact.

* + - * 1. Welded-Wire Mesh: Intermediate-crimp or lock-crimp as indicated, 0.50-inch by 3-inch by 0.128 (10 ga) welded-wire mesh, complying with ASTM A510.
			1. ALUMINUM RAILINGS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Fixfast USA.

Hollaender Mfg. Co.

Superior Aluminum Products, Inc.

Approved equivalent.

* + - * 1. Source Limitations: Obtain each type of railing from single source from single manufacturer.

Retain applicable material types, qualities, and grades from paragraphs below.

* + - * 1. Aluminum, General: Provide alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of alloy and temper designated below for each aluminum form required.

Alloys and tempers in first six paragraphs below are typical for products listed when used in railings; revise to suit structural performance requirements.

Aluminum railings are usually made from round tubing rather than pipe. For round tube railings, usually retain first three paragraphs below if Contractor is required to design railings. For pipe railings, retain only second paragraph unless first paragraph is required for bars. For square tube railings, retain only first paragraph. Primary difference between round tubing and pipe is in OD. Pipe sizes are normally indicated by use of NPS designator and weight class or schedule number; for tubing, OD and wall thickness are used. See the Evaluations.

Yield strength for Alloy 6063-T5/T52 is 15 to 16 ksi.

* + - * 1. Extruded **[Bars] [and] [Tubing]**: ASTM B221, Alloy 6063-T5/T52.

Yield strength for Alloy 6063-T6 is 25 ksi.

* + - * 1. Extruded Structural **[Pipe] [and] [Round Tubing]**: ASTM B429, Alloy 6063-T6.

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

Yield strength for Alloy 6063-T832 is 35 to 36 ksi.

* + - * 1. Drawn Seamless Tubing: ASTM B210, Alloy 6063-T832.

Yield strength for Alloy 6061-T6 is 32 to 35 ksi. Note that 6061-T6 is unsuitable for bending, is somewhat less corrosion resistant than 6063, and does not anodize as well as 6063; however, 6063 is not available in plate and sheet form.

* + - * 1. Plate and Sheet: ASTM B209, Alloy 6061-T6.
				2. Die and Hand Forgings: ASTM B247, Alloy 6061-T6.
				3. Castings: ASTM B26, Alloy A356.0-T6.
				4. Perforated Metal Infill Panels: Aluminum sheet, ASTM B209, Alloy 6061-T6, 0.063 inch thick, with 1/4-inch holes 3/8 inch o.c. in staggered rows.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product.

Basis-of-Design Product: Provide product with perforations matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.

* + - * 1. Woven-Wire Mesh Infill Panels: Intermediate-crimp, **[diamond] [square]** pattern, 2-inch woven-wire mesh, made from 0.162-inch- diameter aluminum wire complying with ASTM B211, Alloy 6061-T94.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product.

Basis-of-Design Product: Provide product with crimp pattern matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.

* + - 1. STAINLESS STEEL RAILINGS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Trex Commercial Products, Inc.

Tubular Specialties Manufacturing, Inc.

Wagner Companies (The); R&B Wagner, Inc.

Approved equivalent.

* + - * 1. Source Limitations: Obtain each type of railing from single source from single manufacturer.

Retain applicable material types, qualities, and grades from paragraphs below. Type 304 stainless steel is usually standard; Type 316 or 316L provides better corrosion resistance in coastal environments and where subject to deicing salts. If welding is required, use Type 316L instead of Type 316.

Stainless steel railings are usually made from tubing rather than pipe. Stainless steel tubing is not annealed, pickled, or pressure tested, so it is less expensive than stainless steel pipe. Primary difference between round stainless steel tubing and stainless steel pipe is in OD. Pipe sizes are typically indicated by use of NPS designator and weight class or schedule number; for tubing, OD and wall thickness are used. See Evaluations.

* + - * 1. Tubing: ASTM A554, **[Grade MT 304] [Grade MT 316L]**.
				2. Pipe: ASTM A312, **[Grade TP 304] [Grade TP 316L]**.

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

* + - * 1. Castings: ASTM A743, **[Grade CF 8 or CF 20] [Grade CF 8M or CF 3M]**.
				2. Plate and Sheet: ASTM A240 or ASTM A666, **[Type 304] [Type 316L]**.
				3. Expanded Metal Infill Panels: ASTM F1267, **[Type I (expanded)] [Type II (expanded and flattened)]**, Class 3 (corrosion-resistant steel), made from stainless steel sheet, ASTM A240 or ASTM A666, **[Type 304] [Type 316]**.

Designations in "Style Designation" Subparagraph below indicate size. 3/4 number 13 has openings approximately 3/4 by 1-1/2 inches and is 0.09 to 0.10 inch thick; 1-1/2 number 10 has openings approximately 1 by 2-1/2 inches and is 0.13 to 0.142 inch thick.

Style Designation: **[3/4 number 13] [1-1/2 number 10]**.

* + - * 1. Perforated Metal Infill Panels: Stainless steel sheet, ASTM A240 or ASTM A666, **[Type 304] [Type 316L], [0.062 inch]** thick, **[with 1/4-inch holes 3/8 inch o.c. in staggered rows]**.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product.

Basis-of-Design Product: Provide product with perforations matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.

* + - * 1. Woven-Wire Mesh Infill Panels: Intermediate-crimp, **[diamond] [square]** pattern, 2-inch woven-wire mesh, made from 0.141-inch- diameter stainless steel wire complying with ASTM A580, **[Type 304] [Type 316]**.

Retain "Basis-of-Design Product" Subparagraph below to identify a specific product.

Basis-of-Design Product: Provide product with crimp pattern matching **[product indicated on Drawings] <Insert manufacturer's name; product name or designation>**.

Use the Article below for DOCCS projects where there is inmate contact.

* + - * 1. Welded-Wire Mesh: Intermediate-crimp or lock-crimp as indicated, Square pattern, 2-inch welded-wire mesh, made from 0.375-inch nominal-diameter stainless steel wire complying with ASTM A580.

Use the Article below for DOCCS projects where non-climbing mesh is required and there is inmate contact.

* + - * 1. Welded-Wire Mesh: Intermediate-crimp or lock-crimp as indicated, 0.50-inch by 3-inch by 0.128 (10 ga) welded-wire mesh, complying with ASTM A580.
			1. FASTENERS
				1. Fastener Materials:

Ungalvanized-Steel Railing Components: Plated steel fasteners complying with ASTM F1941, Class Fe/Zn 5 for zinc coating.

Many fasteners, such as small-diameter machine screws, are not available hot-dip galvanized.

Hot-Dip Galvanized Railing Components: Type 316 stainless steel or hot-dip zinc-coated steel fasteners complying with ASTM A153 or ASTM F2329 for zinc coating.

Aluminum Railing Components: **[Type 304] [Type 316]** stainless steel fasteners.

Stainless Steel Railing Components: **[Type 304] [Type 316]** stainless steel fasteners.

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

Finish exposed fasteners to match appearance, including color and texture, of railings.

* + - * 1. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction**[ and capable of withstanding design loads]**.
				2. Fasteners for Interconnecting Railing Components:

Retain one of first two subparagraphs below.

Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.

Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

Delete subparagraph below or revise if another type of head is required or is standard with system selected.

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

In "Post-Installed Anchors" Paragraph below, ICC-ES AC193 is for mechanical anchors, and ICC-ES AC308 is for adhesive anchors.

* + - * 1. Post-Installed Anchors: Fastener systems with working capacity greater than or equal to the design load, according to 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.

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

Alloy Group 1 (A1) refers to Type 304 and similar alloys, and Alloy Group 2 (A4) refers to Type 316 and similar alloys.

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

Material for Exterior Locations: Alloy Group 2 stainless-steel bolts, ASTM F593, and nuts, ASTM F594.

* + - 1. MISCELLANEOUS MATERIALS
				1. Handrail Brackets: **[Cast iron] [Cast aluminum,] [Cast stainless steel,] [Cast nickel-silver,]** center of handrail **[2-1/2 inches] [3-1/8 inches] <Insert dimension>** from **[face of railing] [wall]**.
				2. Welding Rods and Bare Electrodes: Select in accordance with AWS specifications for metal alloy welded and welding procedure specification.

For **[aluminum] [and] [stainless steel]** railings, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

* + - * 1. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
				2. Galvanizing Repair Paint: High-zinc-dust-content paint, complying with SSPC-Paint 20 and compatible with paints specified to be used over it.

Retain one or more of "Shop Primers," "Universal Shop Primer," "Epoxy Zinc-Rich Primer," and "Shop Primer for Galvanized Steel" paragraphs below.

* + - * 1. Shop Primers: Provide primers that comply with **[Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]**

"Universal Shop Primer" Paragraph below specifies a typical primer for painted finishes that provides minimum protection to steel.

* + - * 1. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.

Use primer containing pigments that make it easily distinguishable from zinc-rich primer.

"Epoxy Zinc-Rich Primer" Paragraph specifies a typical primer for high-performance coating.

* + - * 1. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
				2. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
				3. Intermediate Coats and Topcoats: Provide products that comply with **[Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]**
				4. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
				5. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
				6. Bituminous Paint: Cold-applied asphalt emulsion, complying with ASTM D1187.

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

* + - * 1. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout, complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
				2. 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.

Water-Resistant Product: **[At exterior locations] [and] [where indicated on Drawings]**, 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.

* + - 1. FABRICATION
				1. General: 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]**.
				2. Shop assemble railings 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.

* + - * 1. 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.

* + - * 1. Form work true to line and level with accurate angles and surfaces.
				2. Fabricate connections that are exposed to weather in a manner that excludes water.

Provide weep holes where water may accumulate.

Locate weep holes in inconspicuous locations.

* + - * 1. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
				2. Connections: Fabricate railings with welded or bolted connections unless otherwise indicated.

"Welded Connections" Paragraph below is generally applicable to exposed welding of steel and stainless steel.

* + - * 1. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.

Comply with AWS requirements and approved welding procedure specifications.

Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

Obtain fusion without undercut or overlap.

Remove flux immediately.

At exposed connections, finish exposed welds to comply with NOMMA's "Voluntary Joint Finish Standards" for **[Finish #1 welds; ornamental quality with no evidence of a welded joint] [Finish #2 welds; good appearance, completely sanded joint, some undercutting and pinholes okay] [Finish #3 welds; utilitarian appearance not subject to view, partially dressed weld with spatter removed]**

"Welded Connections for Aluminum Pipe" Paragraph below is an example only and is based on CraneVeyor's system.

* + - * 1. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
				2. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

Subparagraph below is an alternative to concealed mechanical fasteners and fittings.

Fabricate splice joints for field connection, using an epoxy structural adhesive, if this is manufacturer's standard splicing method.

* + - * 1. Form changes in direction as follows:

Retain one of four 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.

As detailed.

**[By bending] [or] [by inserting prefabricated elbow fittings]**.

**[By flush bends] [or] [by inserting prefabricated flush-elbow fittings]**.

**[By radius bends of radius indicated] [or] [by inserting prefabricated elbow fittings of radius indicated]**.

By bending to smallest radius that will not result in distortion of railing member.

Retain first paragraph below if bending is allowed or required.

* + - * 1. 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.
				2. Close exposed ends of hollow railing members with prefabricated cap and end fittings of same metal and finish as railings.
				3. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
				4. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

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

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 prevent bracket or fitting rotation and crushing of substrate.

* + - * 1. 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 first paragraph below if no posts are set in concrete or if posts are set without sleeves.

* + - * 1. For railing posts set in concrete, provide 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. For removable railing posts, fabricate slip-fit sockets from stainless steel tube or pipe whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height.

Provide socket covers designed and fabricated to resist being dislodged.

Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

* + - * 1. Expanded-Metal Infill Panels: Fabricate infill panels from expanded-metal sheet of same metal as railings.

Edge panels with U-shaped channels made from metal sheet, of same metal as expanded metal and not less than 0.043 inch thick.

Orient expanded metal with long dimension of diamonds **[parallel to top rail] [perpendicular to top rail] [horizontal] [vertical]**.

* + - * 1. Perforated-Metal Infill Panels: Fabricate infill panels from perforated metal made from **[steel] [galvanized steel] [aluminum] [stainless steel] [same metal as railings in which they are installed]**.

Edge panels with U-shaped channels made from metal sheet, of same metal as perforated metal and not less than 0.043 inch thick.

Orient perforated metal with pattern **[parallel to top rail] [perpendicular to top rail] [horizontal] [vertical] [as indicated on Drawings]**.

* + - * 1. Woven-Wire Mesh Infill Panels: Fabricate infill panels from woven-wire mesh crimped into 1-by-1/2-by-1/8-inch metal channel frames.

Fabricate wire mesh and frames from same metal as railings in which they are installed.

Orient wire mesh with **[diamonds vertical] [diamonds perpendicular to top rail] [wires perpendicular and parallel to top rail] [wires horizontal and vertical] [as indicated on Drawings]**.

Retain "Toe Boards" Paragraph below if required for protection against objects falling over edge on to trafficked surfaces.

* + - * 1. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated.
			1. STEEL AND IRON FINISHES
				1. Galvanized Railings:

Retain first subparagraph below and delete both options if all railings, both interior and exterior, are galvanized. Retain second option if only certain steel railings are galvanized; indicate locations of galvanized railings on Drawings.

Hot-dip galvanize [exterior] [indicated] steel railings, including hardware, after fabrication.

Comply with ASTM A123 for hot-dip galvanized railings.

Comply with ASTM A153 for hot-dip galvanized hardware.

Retain first subparagraph below if galvanized railings are painted.

Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.

Usually retain subparagraph below for railings hot-dip galvanized after fabrication.

Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

* + - * 1. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.
				2. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner**[ and as follows]**.

Comply with SSPC-SP 16.

* + - * 1. For nongalvanized-steel railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves; however, hot-dip galvanize anchors to be embedded in exterior concrete or masonry.

Retain "Preparation for Shop Priming" Paragraph below for nongalvanized railings.

* + - * 1. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with **[SSPC-SP 6/NACE No. 3.] [SSPC-SP 3.] [requirements indicated below:]**

Retain or revise any of four subparagraphs below to suit Project service conditions of installed work. Insert other exposures and preparation requirements where applicable. See PB-01601: "Good Painting Practice: SSPC Painting Manual," Vol. 1, and PB-00802: "Systems and Specifications: SSPC Painting Manual," Vol. 2.

Exterior Railings: SSPC-SP 6/NACE No. 3.

Railings Indicated To Receive Zinc-Rich Primer: SSPC-SP 6/NACE No. 3.

Railings Indicated To Receive Primers Specified in Section 099600 "High-Performance Coatings": SSPC-SP 6/NACE No. 3.

Other Railings: SSPC-SP 3.

* + - * 1. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1 for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

Delete first subparagraph below if only one shop primer for uncoated steel is specified.

Shop prime uncoated railings with **[universal shop primer] [primers specified in Section 099123 "Interior Painting"]** unless **[zinc-rich primer is] [primers specified in Section 099600 "High-Performance Coatings" are]** indicated.

Delete subparagraph below if galvanized railings are shop primed.

Do not apply primer to galvanized surfaces.

* + - * 1. Shop-Painted Finish: Comply with **[Section 099600 "High-Performance Coatings."]**

Color: **[As indicated by manufacturer's designations] [Match Director’s Representative's sample] [As selected by Director’s Representative from manufacturer's full range]**.

If retaining "High-Performance Coating" Paragraph below, also retain "Primer Application" Paragraph.

* + - * 1. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1 for shop painting. Apply at spreading rates recommended by coating manufacturer.

Color: **[As indicated by manufacturer's designations] [Match Director’s Representative's sample] [As selected by Director’s Representative from manufacturer's full range]**.

* + - 1. ALUMINUM FINISHES

Delete "Appearance of Finished Work" Paragraph below if no variable finishes, such as color-anodized aluminum, are used.

* + - * 1. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are unacceptable. 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 or revise finishes below to suit Project. If retaining more than one, indicate location of each on Drawings or by inserts. Revise mill finish if custom mechanical finish is required and availability is verified.

* + - * 1. Mill Finish: AA-M12, nonspecular as fabricated.

Retain one of two options in "Clear Anodic Finish" Paragraph below. Second option is standard with many manufacturers; first option is heavy anodized. Verify availability with manufacturers.

* + - * 1. Clear Anodic Finish: AAMA 611, **[AA-M12C22A41] [AA-M12C22A31]**.

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

* + - * 1. Color Anodic Finish: AAMA 611, **[AA-M12C22A42/A44] [AA-M12C22A32/A34]**.

Color: **[Light bronze] [Medium bronze] [Dark bronze] [Black] [Match Director’s Representative's sample] [As selected by Director’s Representative from full range of industry colors and color densities]**.

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

* + - * 1. 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.

Color and Gloss: **[As indicated by manufacturer's designations] [Match Director’s Representative's sample] [As selected by Director’s Representative from manufacturer's full range]**.

Retain "High-Performance Organic Finish, Two-Coat Polyvinylidene Fluoride (PVDF)"; "Superior Performance Organic Finish, Three-Coat Polyvinylidene Fluoride (PVDF)"; "Superior Performance Organic Finish, Four-Coat Polyvinylidene Fluoride (PVDF)"; "Single-Coat Superior Performance FEVE Organic Finish"; or "Two-Coat Superior Performance FEVE Organic Finish" Paragraph below. If more than one finish 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 Polyvinylidene Fluoride (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.

* + - * 1. High-Performance Organic Finish, Two-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with **[AAMA 2604] [AAMA 2605]** and containing not less than **[50] [70]** percent polyvinylidene fluoride (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]**.

Color and Gloss: **[As indicated by manufacturer's designations] [Match Director’s Representative's sample] [As selected by Director’s Representative from manufacturer's full range]**.

* + - * 1. Superior Performance Organic Finish, Three-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (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]**.

Color and Gloss: **[As indicated by manufacturer's designations] [Match Director’s Representative's sample] [As selected by Director’s Representative from manufacturer's full range]**.

* + - * 1. Superior Performance Organic Finish, Four-Coat Polyvinylidene Fluoride (PVDF): Fluoropolymer finish complying with AAMA 2605 and containing not less than 70 percent polyvinylidene fluoride (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]**.

Color and Gloss: **[As indicated by manufacturer's designations] [Match Director’s Representative's sample] [As selected by Director’s Representative from manufacturer's full range]**.

"Single-Coat Superior Performance FEVE Organic Finish" Paragraph below is unsuitable for seacoast and severe environments.

* + - * 1. Single-Coat Superior Performance FEVE Organic Finish: Single-coat fluoroethylene vinyl ether (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.

Color and Gloss: **[As indicated by manufacturer's designations] [Match Director’s Representative's sample] [As selected by Director’s Representative from manufacturer's full range]**.

* + - * 1. Two-Coat Superior Performance FEVE Organic Finish: Two-coat fluoroethylene vinyl ether (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.

Color and Gloss: **[As indicated by manufacturer's designations] [Match Director’s Representative's sample] [As selected by Director’s Representative from manufacturer's full range]**.

* + - 1. STAINLESS STEEL FINISHES
				1. Surface Preparation: Remove tool and die marks and stretch lines, or blend into finish.
				2. Polished Finishes: Grind and polish surfaces to produce uniform finish, free of cross scratches.

Retain first subparagraph below for directional finishes.

Run grain with long dimension of each piece.

When polishing is completed, passivate and rinse surfaces.

Remove embedded foreign matter and leave surfaces chemically clean.

* + - * 1. Stainless Steel Pipe and Tubing Finishes:

Retain "180-Grit Polished Finish," "320-Grit Polished Finish," or "Polished and Buffed Finish" subparagraphs below. Coordinate with other Sections that include stainless steel railings to ensure uniform finish throughout Project, if desired, as 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 grab bars, handrails, and restaurant equipment tubing.

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

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

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

Polished and buffed finish in paragraph below is similar to ASTM A480 No. 7 finish for sheet and plate.

Polished and Buffed Finish: 320-grit finish followed by buffing **[to a high luster finish] [to a mirror-like finish] [to match Director’s Representative's sample]**.

* + - * 1. Stainless Steel Sheet and Plate 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 120- to 320-grit polished finish.

Directional Satin Finish: ASTM A480, 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.

High-Luster Finish: ASTM A480, No. 7.

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

Mirror Finish: ASTM A480, No. 8.

1. EXECUTION
	* + 1. EXAMINATION

Delete this article if no handrails are attached to plaster or gypsum board assemblies.

* + - * 1. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.
			1. INSTALLATION, GENERAL
				1. Perform cutting, drilling, and fitting required for installing railings.

Fit exposed connections together to form tight, hairline joints.

Install railings level, plumb, square, true to line; without distortion, warp, or rack.

Set railings accurately in location, alignment, and elevation; measured from established lines and levels.

Do not weld, cut, or abrade surfaces of railing components that are 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."

Set posts plumb within a tolerance of 1/16 inch in 3 feet.

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.

* + - * 1. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

Coat concealed surfaces of aluminum that will be in contact with grout, concrete, masonry, wood, or dissimilar metals, with a heavy coat of bituminous paint.

* + - * 1. Adjust railings before anchoring to ensure matching alignment at abutting joints.
				2. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.
			1. RAILING CONNECTIONS

Delete "Nonwelded Connections" or "Welded Connections" Paragraph below unless both methods are required. If both mechanical and welded connections are required, indicate locations of each on Drawings.

* + - * 1. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws, using plastic cement filler colored to match finish of railings.
				2. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article, whether welding is performed in the shop or in the field.

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.

* + - * 1. 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.
			1. ANCHORING POSTS

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

Retain one of first two paragraphs below, or delete both if not using posts in concrete. Coordinate with products retained in Part 2.

* + - * 1. Use stainless steel pipe sleeves preset and anchored into concrete for installing posts. After posts are inserted into 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.
				2. 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.

* + - * 1. Cover anchorage joint with flange of same metal as post, **[welded to post after placing anchoring material] [attached to post with setscrews]**.
				2. 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.

* + - * 1. 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 should be specially detailed.

For steel railings, weld flanges to post and bolt to metal supporting surfaces.

For aluminum railings, attach posts as indicated, using fittings designed and engineered for this purpose.

For stainless steel railings, weld flanges to post and bolt to supporting surfaces.

Retain paragraph below if applicable.

* + - * 1. Install removable railing sections, where indicated, in slip-fit stainless steel sockets cast in concrete.
			1. ATTACHING RAILINGS

Delete first two paragraphs below if railing ends are not returned to walls.

* + - * 1. Anchor railing ends to concrete and masonry with **[sleeves concealed within] [flanges connected to] [brackets on underside of rails connected to]** railing ends and anchored to wall construction with anchors and bolts.
				2. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and **[welded to railing ends] [or] [connected to railing ends, using nonwelded connections]**.
				3. Attach handrails to walls with wall brackets**[, except where end flanges are used]**. Provide brackets with **[1-1/2-inch] <Insert dimension>** clearance from inside face of handrail and finished wall surface.

Use type of bracket with **[flange tapped for concealed anchorage to threaded hanger bolt] [predrilled hole for exposed bolt anchorage]**.

Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.

* + - * 1. Secure wall brackets**[ and railing end flanges]** to building construction as follows:

For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.

For hollow masonry anchorage, use toggle bolts.

For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.

Retain one of three subparagraphs below if using steel studs.

For steel-framed partitions, use hanger or lag bolts set into **[fire-retardant-treated ]**wood backing between studs. Coordinate with stud installation to locate backing members.

For steel-framed partitions, fasten brackets directly to steel framing or concealed steel reinforcements, using self-tapping screws of size and type required to support structural loads.

* + - 1. REPAIR
				1. Touchup Painting:

Retain first subparagraph below if touchup painting is specified in this Section.

Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.

Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

Retain "Touchup Painting" Subparagraph below if touchup painting is not specified in this Section.

* + - * 1. Touchup Painting: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in **[Section 099123 "Interior Painting."] [Section 099600 "High-Performance Coatings."]**
			1. CLEANING
				1. Clean **[aluminum] [and] [stainless steel]** by washing thoroughly with clean water and soap and rinsing with clean water.
				2. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A780.
			2. PROTECTION
				1. 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.
				2. 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 055213