SECTION 05521 - PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.01 DESCRIPTION

A. Work of this section is subject to requirements of the Contract Documents including the General Conditions and Supplementary Conditions and applicable portions of Division 1 - General Requirements.

B. The work consists of all labor, materials and equipment necessary and required to complete all pipe and tube railings as shown on the drawings and specified herein.

1.02 RELATED WORK SPECIFIED ELSEWHERE

A. Steel pan stairs: Section 05500.

B. Finish Painting: Section 09900.

C. Ornamental Handrails and Railings: Section 05720.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

A. Structural Performance of Pipe and Tube Railing Systems: Engineer, fabricate, and install railing systems to withstand the following structural loads without exceeding the allowable design working stress of the materials for railing systems, anchors, and connections. Apply each load to produce the maximum stress in each of the respective components comprising handrails and railing systems.

1. Top Rail of Guardrail Systems: Capable of withstanding the following loads applied as indicated.

   a. Concentrated load of 300 pounds applied at any point non-concurrently, vertically downward, or horizontally..

   b. Uniform load of 100 pounds per linear foot applied non-concurrently, vertical downward or horizontally.

   c. Concentrated and uniform loads above need not be assumed to act concurrently.

2. Handrails Not Serving as Top Rails: Capable of withstanding the following loads applied as indicated:

   a. Concentrated load of 200 pounds applied at any point non-concurrently, vertically downward or horizontally.

   b. Uniform load of 50 pounds per linear foot applied non-concurrently, vertically downward or horizontally.

   c. Concentrated and uniform loads above need not be assumed to act concurrently.

3. Infill Area of Guardrail Systems: Capable of withstanding a horizontal concentrated load of 200 pounds applied to one square foot at any point in the system including intermediate rails, balusters, or other elements composing the infill area.

a. Above load need not be assumed to act concurrently with uniform horizontal loads on top rails of railing systems in determining stress on guard.

4. Comply with requirements of ASTM E 985 for structural performance based on the following:

a. Testing performed in accordance with ASTM C 894 and ASTM E 935.

b. Structural computations.

B. Thermal Movements: Allow for thermal movement resulting from the following maximum change (range) in ambient temperature in the design, fabrication and installation of pipe and tube railings to prevent buckling, opening up of joints and over-stressing of components, connections, and other detrimental effects. Base design calculation on actual surface temperatures of materials due to both solar heat gain and night-time sky heat loss.

1. Temperature Change (Range): 120 degrees F, ambient; 180 degrees F, material surfaces.

1.04 SUBMITTALS

A. Product data for each type of product specified.

B. Shop drawings showing fabrication and installation of handrails and railings including plans, elevations, sections, details of components, and attachments to other units of work.

1. Where installed products are indicated to comply with certain design loadings, include structural computations, material properties, and other information needed for structural analysis along with the shop drawings that have been signed and sealed by an Illinois licensed structural engineer responsible for their preparation.

C. Samples for initial selection purposes in form of actual metal in types of finishes available.

1.05 QUALITY ASSURANCE

A. Engineer Qualifications: Illinois licensed structrual engineer legally authorized to practice in jurisdiction where project is located and experienced in providing engineering services of the kind indicated for handrails and railings similar in material, design, and extent to that indicated for this project and that have a record of successful in-service performance.

B. Testing Laboratory Qualifications: To qualify for acceptance, an independent testing laboratory must demonstrate to Architect’s satisfaction, based on evaluation of laboratory submitted criteria conforming to ASTM E 699, that it has the experience and capability to conduct satisfactorily the testing indicated without delaying the progress of the work.

1.06 STORAGE

A. Store pipe and tube railing systems in clean, dry location away from uncured concrete and masonry, protected against damage of any kind. Cover with waterproof paper, tarpaulin, or polyethylene sheeting; allow for air circulation inside the covering.

1.07 PROJECT CONDITIONS

A. Field Measurements: Where pipe and tube railings are indicated to fit to other construction, check actual dimensions of other construction by accurate field measurements before fabrication; show recorded measurements on final shop drawings. Coordinate fabrication schedule with construction progress to avoid delay of work.

1. Where field measurements cannot be made without delaying the work, guarantee dimensions and proceed with fabrication of products without field measurements.

Coordinate other construction to ensure that actual dimensions correspond to guaranteed dimensions.

1.08 SEQUENCING AND SCHEDULING

A. Sequence and coordinate installation of wall handrails as follows:

1. Mount handrails only on completed walls. Do not support handrails temporarily by any means not satisfying structural performance requirements.

2. Mount handrails only on gypsum board assemblies reinforced to receive anchors and where the location of concealed anchor plates has been clearly marked for benefit of installer.

3. Furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, weld plates, and anchor bolts. Coordinate delivery of such items to Project site. Unless otherwise shown or required, use drilled-in expansion anchors for concrete and solid masonry, and toggle bolts with square heads for hollow masonry.

PART 2 - PRODUCTS

2.01 METALS

A. General: Provide metal forms and types that comply with requirements of referenced standards and are free from surface blemishes where exposed to view in the finished unit. Exposed to view surfaces exhibiting pitting, seam marks, roller marks, stains, discoloration, or other imperfections on finished units are not acceptable.

B. Steel and Iron: Provide steel and iron in the form indicated complying with the following requirements.

1. Cold-Formed Steel Tubing: ASTM A 500, grade as indicated below:

a. Grade A, unless otherwise indicated or required by structural loads.

b. Grade B, unless otherwise indicated or required by structural loads.

2. Hot-Formed Steel Tubing: ASTM A 501.

3. For exterior installations and where indicated, provide tubing with hot-dip galvanized coating per ASTM A 53.

C. Steel Plates, Shapes and Bars: ASTM A 36.

D. Malleable Iron Castings: ASTM A 47, Grade 32510.

E. Steel pipe: ASTM A 53, finish, type and weight class as follows:

1. Black finish, unless otherwise indicated.

2. Galvanized finish for exterior installations and where indicated.

3. Standard weight (schedule 40), unless otherwise indicated, or another weight, type and grade required by structural loads.

F. Gray Iron Castings: ASTM A 48, Class 30.

G. Brackets, Flanges and Anchors: Cast or formed metal of the same type material and finish as supported rails, unless otherwise indicated.

H. Welding Rods, and Bare Electrodes: Select in accordance with AWS specifications for the metal alloy to be welded.

2.02 GUARDRAIL INFILL MATERIALS

A. Provide 2 inch by 2 inch woven wire mesh steel fabric, square pattern, infill panels of sizes indicated.

2.03 GROUT AND ANCHORING CEMENT

A. Non-Shrink Non-Metallic Grout: Pre-mixed, factory packaged, non-staining, non-corrosive, non-gaseous grout complying with CE CRD-C 621. Provide grout specifically recommended by manufacturer for interior and exterior applications of type specified in this section.

B. Interior Anchoring Cement: Factory pre-packaged, non-shrink, non-staining, hydraulic controlled expansion cement formulation for mixing with water at project site to create pourable anchoring, patching and grouting compound. Use for interior applications only.

C. Erosion resistant anchoring cement: Factory pre-packaged, non-shrink, non-staining, hydraulic controlled expansion cement formulation for mixing with water at project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without need for protection by a sealer or waterproof coating and is recommended for exterior use by manufacturer.

D. Products: Subject to compliance with requirements, provide one of the following:

1. Non-Shrink Non-Metallic Grouts:
    a. “Masterflow 713”; BASF Admixtures.
    b. “Sealtight 588 Grout”; W. R. Meadows, Inc.
    c. “Sonogrout”; BASF Building Systems.
2. Interior Anchoring Cement:
    a. “Por-Rok”; Minwax.
    b. “Anchor Tight Cement”; Dayton Superior.
3. Erosion resistant anchoring cement:
    a. “Super Por-Rok”; Minwax.
    b. “Thoro Grip”; BASF Building Systems.

2.04 PAINT

A. Galvanizing Repair Paint: High zinc dust content paint for re-galvanizing welds in galvanized steel, with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035 or SSPC-Paint-20.

B. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint-12 except containing no asbestos fibers.

C. Zinc Chromate Primer: FS TT-P-645.

D. Shop Primer for Ferrous Metal: Manufacturer’s or fabricator’s standard, fast-curing, lead-free, universal modified alkyd primer selected for good resistance to normal atmospheric corrosion, for compatibility with finish paint systems indicated, and for capability to provide a sound foundation for field-applied topcoats despite prolonged exposure complying with performance requirements of FS TT-P-645.

2.05 FASTENERS

A. Fasteners for Anchoring Railings to Other Construction: Select fasteners of the type, grade and class required to produce connections that are suitable for anchoring railing to other types of construction indicated and capable of withstanding design loadings.

1. For steel railings and fittings use plated fasteners complying with ASTM B 633, Class Fe/Zn 25 for electro-deposited zinc coating or ASTM B 696, Class 12 for cadmium plating.

B. Fasteners for Inter-Connecting Railing Components: Use fasteners of same basic metal as the fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.

1. Provide concealed fasteners for interconnection of handrail and railing components and for their attachment to other work, except where otherwise indicated.

2. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

C. Cast-In-Place and Post-Installed Anchors in Concrete: Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, load imposed within a safety factor of 4, as determined by testing per ASTM E 488, conducted by a qualified independent testing laboratory.

1. Expansion anchors.

2.06 FABRICATION

A. General: Fabricate pipe and tube railing systems to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of hollow members, post spacing, and anchorage, but not less than that required to support structural loads.

B. Pre-assembly railing systems in 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. Clearly mark units for reassembly and coordinated installation.

C. Form changes in direction of railing members as follows:

1. By insertion of pre-fabricated elbow fittings.

2. By radius bends of radius indicated.

3. By mitering at elbow bends.

4. By bending.

5. By any method indicated above, applicable to change of direction involved.

D. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, cracking or otherwise deforming exposed surfaces of handrail and railing components.

E. Welded Connections: Fabricate railing systems and handrails for connection of members by welding. For connections made during fabrication, weld corners and seams continuously to comply with the following:

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

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surface match those adjacent.

F. Non-Welded Connections: Fabricate railing systems for connection of members by means of

standard concealed mechanical fasteners and fittings unless otherwise indicated. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using epoxy structural adhesive where this represents standard splicing method.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors for connection of handrail and railing members to other construction.

H. Provide inserts and other anchorage devices for connecting pipe and tube railing systems to concrete or masonry work. Fabricate anchorage devices capable to withstanding loadings imposed by handrails and railing systems. Coordinate anchorage devices with supporting structure.

I. For railing posts set in concrete provide pre-set sleeves of steel, not less than 6 inches long and inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.

J. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

K. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

L. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware, screws, and similar items.

M. For pipe and tube railing systems that are exposed to exterior or to moisture from condensation or other sources, provide weepholes or other means for evacuation of entrapped water in hollow sections of railing members.

N. Fabricate joints that will be exposed to weather in a manner to exclude water.

O. Close exposed ends of pipe and tube railing members by use of pre-fabricated end fittings.

P. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns unless clearance between end of railing and wall is 1/4 inch or less.

Q. Toe Boards: Where indicated, provide toe boards at railings around openings and at the edge of open-sided floors and platforms. Fabricate to dimensions and details indicated for connection to, and centered between, each railing post.

R. Fillers: Provide steel sheet or plate fillers of thickness and size indicated or required to support structural loads of handrails where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses. Size fillers to produce adequate bearing to prevent bracket rotation and over-stressing of substrate.

2.07 FINISHES, GENERAL

A. Comply with NAAMM “Metal Finishes Manual” for recommendations relating to application and designations of finishes.

B. Protect mechanical finishes on exposed surfaces from damage by application of strippable, temporary protective covering prior to shipment.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are not acceptable if they are within 1/2 of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within range of approved samples and they are assembled or installed to minimize contrast.

2.08 GALVANIZED FINISH

A. General: Hot-dip galvanize items indicated to be galvanized to comply with applicable standard listed below:

1. ASTM A 153 for galvanizing iron and steel hardware.

2. ASTM A 123 for galvanizing iron and steel products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips.

B. For exterior steel railings formed from steel tubing with galvanized finish, galvanize fittings, brackets, fasteners, sleeves and other ferrous components.

C. For interior steel railings formed from steel tubing with galvanized finish, galvanize fittings, brackets, fasteners, sleeves and other ferrous components.

D. For interior steel railings formed from non-galvanized steel members, provide non-galvanized ferrous metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.

E. Factory-Primed Finish: Apply air-dried primer immediately following cleaning and pre-treatment to provide a minimum dry film thickness of 2.0 mils per applied coat, to surfaces that will be exposed after assembly and installation and to concealed, non-galvanized surfaces.

2.09 STEEL FINISHES

A. Preparation for Shop Priming: Prepare uncoated ferrous metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:

1. Exteriors (SSPC Zone 1B): SSPC-SP6 “Commercial Blast Cleaning”.

2. Interiors (SSPC Zone 1A): SSPC-SP7 “Brush-Off Blast Cleaning”.

B. Apply shop primer to uncoated surfaces of railing components, except those with galvanized finish or to be embedded in concrete or masonry, unless otherwise indicated. Comply with requirements of SSPC-PA 1 “Paint Application Specification No. 1” for shop painting.

1. Shop Primer: Fabricator’s standard fast-curing, lead-free, “universal” primer, selected for resistance to normal atmospheric corrosion, for compatibility with substrate and field-applied finish paint system indicated, and for capability to provide a sound foundation for field-applied top coats despite prolonged exposure.

2. Stripe paint all edges, corners, crevices, bolts, welds and sharp edges.

PART 3 - EXECUTION

3.01 PREPARATION

A. Coordinate setting drawings, diagrams, templates, instructions and directions for installation of anchorages, such as sleeves, concrete inserts, anchor bolts and miscellaneous items having integral anchors, that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to project site.

3.02 INSTALLATION, GENERAL

A. Fit exposed connections accurately together to form tight hairline joints.

B. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of railings. Set railings accurately in location, alignment and elevation, measured from established lines and levels and free from rack.

1. Do not weld, cut or abrade surfaces of railing components that have been coated or finished after fabrication and are intended for field connection by mechanical or

other means without further cutting or fitting.

2. Set posts plumb within a tolerance of 1/4 inch in 12 feet.

3. Align rails so that variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Field Welding: Comply with the following requirements.

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

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds and surfaces smooth and blended so that no roughness shows after finishing and contour of welded surfaces matches those adjacent.

D. Corrosion Protection: Coat concealed surfaces of the following, which will be in contact with grout, concrete, masonry, wood or dissimilar metals with a heavy coat of bituminous paint or zinc chromate primer.

1. Aluminum alloys.

2. Copper alloys.

E. Adjust pipe and tube railing systems prior to anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated but not less than that required by structural loads.

F. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings to in-place construction.

3.03 RAILING CONNECTIONS

A. Non-Welded Connections: Use manufacturer's standard 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 filler cement colored to match finish of handrails and railing systems.

B. Welded Connections: Use fully welded joints for permanently connecting railing components by welding. Cope or butt components to provide 100 percent contact or use manufacturer's standard fittings designed for this purpose.

C. Expansion Joints: Install expansion joints at locations indicated but not further 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; locate joint within 6 inches of post.

3.04 ANCHORING POSTS

A. Anchor posts in concrete by core drilling holes not less than 5 inches deep and 3/4 inch greater than outside diameter of post. Clean holes of all loose material, insert posts, and fill annular space between post and concrete with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's directions:

1. Non-shrink, non-metallic grout.

2. Non-shrink, non-metallic grout or anchoring cement.

B. Cover anchorage joint with a round flange of same metal at post; attach to post as follows:

1. Welded to post after placement of anchoring material.

C. For exterior installations, leave anchorage joint exposed, wipe off surplus anchoring material and leave 1/8 inch buildup, sloped away from post. For installations exposed on exterior or to flow of water, seal anchoring material to comply with grout manufacturer's directions.

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

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

3.05 ANCHORING RAIL ENDS

A. Anchor rail ends into concrete and masonry with round flanges connected to rail ends and anchored into wall construction with post-installed anchors and bolts.

B. Anchor rail ends to metal surfaces with oval or round flanges.

1. Weld flanges to rail ends.

C. Install removable railing sections where indicated in slip-fit metal sockets cast into concrete. Accurately locate sockets to match post spacing.

3.06 ATTACHMENT OF HANDRAILS TO WALLS

A. Attach handrails to wall with wall brackets and end fittings. Provide bracket with not less than 1-1/2 inch clearance from inside face of handrail and finished wall surface.

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

C. Secure wall brackets and wall return fittings to building construction as follows:

1. Use type of bracket with flange tapped for concealed anchorage to threaded hanger bolt.

2. Use type of bracket with predrilled hole for exposed bolt anchorage.

3. For concrete and solid masonry anchorage, use drilled-in expansion shield and either concealed hanger bolt or exposed lag bolt, as applicable.

4. For hollow masonry anchorage, use toggle bolts with square heads.

3.07 FIELD QUALITY CONTROL

A. Testing Laboratory: Owner will employ and pay an independent testing laboratory to perform field quality control testing.

B. Extent and Testing Methodology: Arrange for testing of complete railing assemblies that are randomly selected by testing laboratory. Test railings per ASTM E 894 and ASTM E 935 for compliance with ASTM E 985.

C. Testing laboratory shall report test results promptly and in writing to Contractor and Architect.

D. Repair or replace railings within areas where test results indicate non-compliance with requirements.

3.08 ADJUSTING

A. Touch-Up Painting: Immediately after erection, clean field welds, bolted connections and abraded areas of shop paint and paint exposed areas with same material.

B. For galvanized surfaces: Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

3.09 PROTECTION

A. Protect finishes of railing systems from damage during construction period by use of temporary

protective coverings. Remove protective covering at time of substantial completion.

B. Restore finishes damaged during installation and construction period so that 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 05521