DIVISION 5
METALS

SECTION 05505
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other sections.
   2. Design of all temporary bracing not indicated on Drawings.
   3. Structural steel members and associated accessories as required for miscellaneous structural steel framing assemblies. See drawings for details.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Division 3 - Concrete.
   4. Section 05522 - Aluminum Railings.
   5. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. Aluminum Design Manual.
   2. American Association of State Highway and Transportation Officials (AASHTO):
      a. Standard Specification for Highway Bridges.
   3. American Institute of Steel Construction (AISC):
      a. Manual of Steel Construction - Allowable Stress Design (ASD).
      b. Specifications for Structural Steel Buildings (referred to herein as AISC specification).
   4. American National Standards Institute (ANSI):
      a. A14.3, Safety Requirements for Fixed Ladders.
      b. ANSI MBG 531, Metal Bar Grating Manual.
   5. ASTM International (ASTM):
      a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
      b. A36, Specification for Carbon Structural Steel.
      c. A47, Specification for Ferritic Malleable Iron Castings.
      d. A48, Specification for Gray Iron Castings.
      e. A53, Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
      f. A108, Specification for Steel Bars, Carbon, Cold Finished, Standard Quality.
      g. A123, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      h. A153, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      i. A197, Specification for Cupola Malleable Iron.
      j. A276, Specification for Stainless Steel Bars and Shapes.
      k. A307, Specification Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
      l. A325, Specification of Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
      m. A490, Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength.
      n. A496, Specification for Steel Wire, Deformed, for Concrete Reinforcement.

o. A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
p. A501, Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
q. A536, Specification for Ductile Iron Castings.
r. A563, Specification for Carbon and Alloy Steel Nuts.
s. A572, Specification for High-Strength Low-Alloy Colombium-Vanadium Structural Steel.
t. A666, Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
u. A668, Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
v. A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
w. A786, Specification for Rolled Steel Floor Plates.
x. A924, Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
y. A992, Standard Specification for Steel for Structural Shapes For Use in Building Framing.
z. B26, Specification for Aluminum-Alloy Sand Castings.
aa. B36, Specification for Brass Plate, Sheet, Strip, and Rolled Bar.
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
cc. B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
dd. B308, Specification for Aluminum-Alloy 6061-T6 Standard Structural Shapes.
ee. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ff. B632, Specification for Aluminum-Alloy Rolled Tread Plate.
gg. F467, Specification for Non-Ferrous Nuts for General Use.
hh. F468, Specification for Non-Ferrous Bolts, Hex Cap Screws, and Studs for General Use.
ii. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
jj. F594, Specification for Stainless Steel Nuts.

6. American Welding Society (AWS):
   a. A5.1, Standard Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. D1.1, Structural Welding Code Steel.
   c. D1.2, Structural Welding Code Aluminum.
   d. D1.3, Structural Welding Code Sheet Steel.
7. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 510, Metal Stairs Manual.
8. Research Council on Structural Connections:
   a. Specification for Structural Joints Using ASTM A325 or A490 Bolts (referred to herein as Specification for Structural Joints).
9. U. S. Department of Labor, Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910, OSHA Safety and Health Standards for General Industry (referred to herein as OSHA Standards).
10. Building code:
   a. International Code Conference (ICC):
      1) International Building Code and associated standards, 2000 Edition, including all City of Kerrville, Texas, 2000 IBC amendments, referred to herein as Building Code.

B. Qualifications:
1. Qualify welding procedures and welding operators in accordance with AWS.
2. Fabricator of manufactured items and manufactured units shall have minimum of 10 years experience in fabrication of metal items specified.
   a. Fabricator shall have in place procedural and quality control programs, which shall include written manuals.

3. Engineer for contractor-designed systems and components: Professional structural engineer licensed in the State of Texas.
   a. Aluminum connections and members not detailed on the Drawings shall be designed by a registered professional Structural Engineer in the State of Texas.

1.3 DEFINITIONS

A. Installer or Applicator: Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   1. Installer or applicator are synonymous.

B. Hardware: As defined in ASTM A153.

C. Galvanizing: Hot-dip galvanizing per ASTM A123 or A153 with minimum coating of 2.0 OZ of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340.
   2. Fabrication and/or layout drawings and details:
      a. Submit drawings for all fabrications and assemblies. Include erection drawings, plans, sections, details and connection details.
      b. Identify materials of construction, shop coatings and third party accessories.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Provide manufacturer's standard allowable load tables for the following:
         1) Expansion anchor bolts.
         2) Adhesive anchor bolts.
         3) Galvanized steel grating.
   4. Contractor designed systems and components, including but not limited to, stairs, and landings: Certification that manufactured units meet all design loads specified.
      a. Shop Drawings and engineering design calculations:
         1) Indicate design live loads.
         2) Sealed by a professional structural engineer.
         3) Engineer will review for general compliance with Contract Documents.

B. Miscellaneous Submittals:
   1. Certification of welders and welding processes.
      a. Indicate compliance with AWS.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle fabrications to avoid damage.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Abrasive stair nosings (embedded in concrete stairs):
      a. American Safety Tread.
      b. Balco.

2. Headed studs and deformed bar anchors:
    a. Nelson Stud Welding Div., TRW Inc.
    b. Stud Welding Products, Inc.
3. Expansion anchor bolts:
    a. Hilti Inc.
    b. ITW Ramset/Red Head.
    c. Powers Rawl.
4. Epoxy adhesive anchor bolts:
    a. Hilti Inc.
    b. ITW Ramset/Red Head.
    c. Powers Rawl.
5. Galvanizing repair paint:
    a. TNEMEC.
    b. ZRC Products.

B. Submit requests for substitution in accordance with Specification Section 01640.

2.2 MATERIALS

A. Steel:
1. Structural:
    a. W-shapes and WT-shapes: ASTM A992, Grade 50.
    b. All other plates and rolled sections: ASTM A36.
2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
3. Structural tubing:
    a. ASTM A500, Grade B (46 ksi minimum yield).
4. Bolts, nuts and washers, high strength: ASTM A325.
    a. Provide two washers with all bolts.
5. Bolts and nuts: Unfinished, ASTM A307, Grade A.
    a. Zinc plated.
6. Welding electrodes: AWS D1.1, E70 Series.
7. Steel forgings: ASTM A668.

B. Iron:
1. Ductile iron: ASTM A536.
2. Gray cast iron: ASTM A48 (minimum 30,000 psi tensile strength).
3. Malleable iron: ASTM A47, A197.

C. Stainless Steel:
1. Minimum yield strength of 30,000 psi and minimum tensile strength of 75,000 psi.
    a. Bars, shapes: ASTM A276, Type 304.
    b. Strip, plate and flat bars: ASTM A666, Type 304 or 316, Grade A.
    c. Bolts and nuts: ASTM F593, Type 303, 304 or 316.
2. Minimum yield strength of 25,000 psi and minimum tensile strength of 70,000 psi.
    a. Strip, plate and flat bar for welded connections, ASTM A666, type 304L or 316L.
3. Welding electrodes: In accordance with AWS for metal alloy being welded.

D. Aluminum:
1. Alloy 6061-T6, 32,000 psi tensile yield strength minimum.
    a. ASTM B221 and B308 for shapes including beams, channels, angles, tees and zees.
2. Alloy 6063-T5 or T6, 15,000 psi tensile yield strength minimum.
    a. ASTM B221 and B429 for bars, rods, wires, pipes and tubes.
3. ASTM B26 for castings.
4. ASTM F468, alloy 2024 T4 for bolts.
5. ASTM F467, alloy 2024 T4 for nuts.
6. Electrodes for welding aluminum: AWS D1.2, filler alloy 4043 or 5356.

E. Washers: Same material and alloy as found in accompanying bolts and nuts.

F. Embedded Anchor Bolts:
   1. Type 304 or 316 stainless steel with matching nut and washer.

G. Expansion Anchor Bolts and Adhesive Anchor Bolts:
   1. Stainless steel, Type 304, 314 or 316.
   2. Provide minimum edge distance cover and spacing as recommended by manufacturer, or as indicated on Drawings whichever is larger.
      a. Minimum embedment as recommended by manufacturer or eight diameters of bolt, whichever is larger.
      b. Notify Engineer if required depth of embedment cannot be achieved at a particular anchor bolt location.
      c. Follow manufacturer's recommendations for installation and torque.
   3. Submit manufacturer's load test data to verify at least the anchor bolt capacities at the following embedment depths:
      a. Data must be based on actual tests performed in unreinforced mass of concrete of not more than 4000 psi compressive strength.
      b. Capacity must be at a concrete temperature of at least 130 DegF.

ANCHOR BOLT DIAMETER (IN)	EMBEDMENT (IN)	MINIMUM ULTIMATE TENSION CAPACITY (KIP)*, **
3/8	3	4.8
½	4	8.1
5/8	5	11.4
¾	6	15.4
7/8	7	20.0
1	8	24.7
1-1/4	10	34.3

* Data must be based on actual tests preformed in unreinforced mass concrete of not more than 4000 psi compressive strength.

** Capacity must be at a concrete temperature of at least 130 DegF.

   4. Expansion anchor bolts:
      a. Kwik Bolt by Hilti, Inc.
      b. Trubolt by ITW Ramset/Red Head.
      c. Powerbolt by Power Rawl.
   5. Adhesive anchor bolts:
      a. HVA Adhesive Anchor System by Hilti.
      b. HIT HY 150 Adhesive Anchor by Hilti.
      c. HSE 2411 Epoxy Adhesive Anchor by Hilti.
      d. EPCON Ceramic 6 Epoxy by ITW Ramset/Red Head.
      e. Power Fast by Powers Rawl.
      f. Needle Capsule Anchor Systems by Powers Rawl.

H. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

I. Deformed Bar Anchors: ASTM A496 with a minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

J. Iron and Steel Hardware: Galvanized in accordance with ASTM A153 when required to be galvanized.

K. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. Dried film shall contain not less than 83 percent zinc dust by weight.
   3. Similar to ZRC by ZRC Products or TNEMEC Series 90-97.

L. Dissimilar Materials Protection: See Section 09905.

2.3 MANUFACTURED UNITS

A. Bollards:
   1. 8 IN DIA extra strength steel pipe, ASTM A53.
   2. Galvanized and painted.
   3. Minimum 60 IN projection above ground.
   4. Minimum 48 IN embedment in concrete.
      a. Provide base plate-type connection for bollards where noted on the Drawings.

B. Abrasive Stair Nosings:
   1. Two component consisting of an embedded subchannel, installed with the concrete pour, and an abrasive tread plate to be installed later.
   2. 6063-T5 extruded aluminum, mill finished and heat treated.
   3. Complete with concrete anchors and tread plate securing screws.
   4. Units: 4 IN less in length than stair width.

C. Metal Stairs: Fabricated as indicated.
   1. Treads: Grating treads as specified with exception that nosing shall have integral corrugated non-slip edge.
   2. Tread Closure Plate: As noted on the drawings.
   3. Landings: Grating as specified.
      a. Provide integral corrugated non-slip nosing at edge acting as stair tread/nosing.
   4. Fabricate and design stair, platforms and landings, and all connections to support a 100 psf uniform live load or a concentrated load of 1000 LBS, whichever requires the stronger component.
   5. Design, fabricate, and install in compliance with NAAMM Metal Stair Manual and applicable codes.
   6. Handrails and guardrails: Refer to Section 05522.
   7. Material as shown on Drawings:
      a. Aluminum.
      b. Galvanized Steel.
   8. Landing construction shall meet all requirements of OSHA 29 CFR 1910 Standards and these Specifications.
         1) Landing platform: Minimum 1-1/2 IN non-slip grating.
         2) Structural support: Channel or tubular sections with bracing, plates, angles, etc. to support guardrail and grating and to support landing off the side of the tank wall.
         3) Guardrail: See Section 05522.
         4) All connections shall be welded or bolted using stainless steel bolts, nuts and washers.
         5) Construct landing, railing and all supports of same material as the ladder.
         6) Landing platform and supporting structure shall be designed for not less than 100 psf plus a concentrated load of 300 LBS with a maximum deflection of 1/300 of span under a superimposed live load of 100 psi.
         7) Attach grating to structure using stainless steel clips and bolts at 24 IN OC maximum spacing.

D. Steel Grating:
   1. ANSI MBG 531.
   2. Bearing bars: Rectangular 1-1/2 x 3/16 IN unless shown otherwise on Drawings.
      a. Maximum 1-3/16 IN OC spacing.
   3. Cross bars: Welded, swagged or pressure locked to bearing bars.
      a. Maximum 4 IN OC spacing.
   4. Top edges of bars: Serrated or grooved.
   5. Removable grating sections: Not wider than 3 FT wire.
   6. Finish: Galvanized.
      a. Clips and bolts: Stainless Steel.
      b. Seat angles: As shown on Drawings.

7. Ends and perimeter edges: Banded.
8. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 IN high toe plate.
9. Provide joints at openings between individual grating sections.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
   1. Grind smooth all rough welds and sharp edges.
      a. Round all corners to approximately 1/32 - 1/16 IN nominal radius.

C. Provide drilled or punched holes with smooth edges.
   1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Permanent Shop Connections:
   1. Welds to be continuous fillet type unless indicated otherwise.
   2. Full penetration butt weld at bends in stair stringers and ladder side rails.
   3. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1.
   4. Weld aluminum in accordance with AWS D1.2.
   5. All headed studs to be welded using automatically timed stud welding equipment.
   6. Grind smooth welds that will be exposed.

E. Conceal fastenings where practicable.

F. Fabricate work in shop in as large assemblies as is practicable.

G. Tolerances:
   1. Rolling: ASTM A6.
      a. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC specifications.
   2. Fabrication tolerance:
      a. Member length:
         1) Both ends finished for contact bearing: 1/32 IN.
         2) Framed members 30 FT or less: 1/16 IN. Over 30 FT: 1/8 IN.
      b. Member straightness:
         1) Compression members: 1/1000 of axial length between points laterally supported.
         2) Non-compression members: ASTM A6/A6M tolerance for wide flange shapes.
      c. At bolted splices, depth deviation shall be taken up by filler plates. At welded joints, adjust weld profile to conform to variation in depth. Slope weld surface per AWS requirements.
      d. Finished members shall be free from twists, bends and open joints. Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

H. Fabricate grating, stairs, and accessories using galvanized steel or aluminum as shown on the Drawings.
   1. Finish for aluminum:
      a. Aluminum: Mill finished unless scheduled or otherwise specified or, if approved by Engineer, finished in manufacturer's standard.
      b. Coat surfaces in contact with dissimilar materials. See Section 09905.
   2. See Section 09905 for preparation and painting of ferrous metals and other surfaces.

I. Maximum tolerance for difference in depth between checker plate and seat or support angle depth: 1/8 IN.

J. Maximum distance between edge of checkered plate and face of embedded seat angle or face of wall or other structural member: 1/4 IN.

2.5 SOURCE QUALITY CONTROL

A. Surface Preparation:
   1. Refer to Section 09905 for surface preparation requirements.

B. Shop Applied Paint Coating Application:
   1. Refer to Section 09905 for painting requirements.

C. OWNER pays for inspection and testing:
   1. Testing: Owner will employ and pay for services of an independent testing agency to inspect and test structural steel field work for compliance with Specifications. Contractor responsible for testing to qualify shop and field welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents. Contractor provides sufficient notification and access so inspection and testing can be accomplished. Contractor pays for retesting of failed tests and for additional testing required when defects are discovered.

D. Responsibilities of Testing Agency:
   1. Inspect shop and field welding in accordance with Section 6 of AWS Code including the following non-destructive testing:
      a. Visually inspect all welds.
      b. In addition to visual inspection, test 50 percent of full penetration welds and 20 percent of fillet welds with liquid dye penetrant.
      c. Test 20 percent of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
   2. Inspect high-strength bolting in accordance with Section 9 of the Specification for Structural Joints.
      a. Verify direct tension indicator gaps.
   3. Inspect structural steel which has been erected.
   4. Inspect stud welding in accordance with Article 7.8, AWS Code.
   5. Prepare and submit inspection and test reports to Engineer. Assist Engineer to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.
   1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate. Installation of product constitutes installer's acceptance of substrate condition for product compatibility.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
   1. Field welding aluminum is not permitted unless approved in writing by Engineer.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.
   1. Shim and grout as necessary.

B. Contractor is solely responsible for safety. Construction means and methods and sequencing of work is the prerogative of the Contractor. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing or rigid connections are installed.
   1. Partially complete structural members shall not be loaded without an investigation by the Contractor.

2. Until all elements of the permanent structure and lateral bracing system are complete, temporary bracing for the partially complete structure will be required.

C. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor. Plumb, align, and set structural steel members to specified tolerances.
   1. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
   2. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
   3. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades. If not obvious from experience or from the Drawings, the Contractor shall confer with the Engineer to identify those structural steel element that must be complete before the temporary bracing system is removed.
   4. Remove and dispose of all temporary work and facilities off-site.

D. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work. Report defects in work-in-place which may influence satisfactory completion of the work. Absence of such notification will be construed as acceptance of work-in-place.

E. Field Measurement: Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings. Contractor responsible for the accurate fit of the work.

F. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection. Use surveyor's level. Notify Engineer of any errors or deviations found by such checking.

G. Framing member location tolerances after erection shall not exceed the frame tolerances listed in Article 3.3.

H. Erect plumb and level; introduce temporary bracing required to support erection loads.

I. Use light drifting necessary to draw holes together. Drifting to match unfair holes is not allowed.

J. Welding: Conform to AWS D1.1 "Structural Welding Code" and requirements of Article 2.4. When joining two sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.

K. Shore existing members when unbolting of common connections is required. Use new bolts for rebolting connections.

L. Clean stored material of all foreign matter accumulated during erection period.

M. Bolt Field Connections: Where practicable, conceal fastenings.

N. Grind welds smooth where field welding is required.

O. Field cutting grating or checkered plate to correct fabrication errors is not acceptable. Replace entire section.

P. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

Q. Unless noted or specified otherwise:
   1. Connect steel members to steel members with 3/4 IN DIA ASTM A325 high strength bolts.
   2. Connect aluminum to aluminum with 3/4 IN DIA aluminum bolts.

3. Connect aluminum to structural steel using 3/4 IN DIA stainless steel bolts. Provide dissimilar metals protection.
4. Connect aluminum and steel members to concrete and masonry using stainless steel expansion anchor bolts or adhesive anchor bolts unless shown otherwise. Provide dissimilar materials protection.
5. Provide washers for all bolted connections.
6. Where exposed, bolts shall extend a maximum of 3/4 IN and a minimum of 1/2 IN above the top nut.
    a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.

R. Install and tighten ASTM A325 high-strength bolts in accordance with the AISC Manual of Steel Construction - Allowable Stress Design (ASD).
1. Provide hardened washers for all ASTM A325 bolts. Provide the hardened washer under the element (nut or bolt head) turned in tightening.
    a. Provide bearing type connection.

S. After bolts are tightened, upset threads of A307 unfinished bolts or anchor bolts to prevent nuts from backing off.

T. Secure metal to wood with lag screws of adequate size with appropriate washers.

U. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing. Provide full penetration welded splices where continuity is required.

V. Provide each fabricated item complete with attachment devices as indicated or required to install.

W. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

X. Set beam and column base plates accurately on nonshrink grout as indicated on Drawings.
1. See Division 3 for non-shrink grout.
2. Set and anchor each base plate to proper line and elevation.
    a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams. Wedges, shims and setting nuts to be of same metal as base plate they support. Tighten nuts on anchor bolts.
    b. Fill space between bearing surface and bottom of base plate with nonshrink grout. Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.
    c. Do not remove wedges or shims. Where they protrude, cut off flush with edge of base plate.
    d. Fill sleeves around anchor bolts solid with non-shrink grout.

Y. Tie anchor bolts in position to embedded reinforcing steel using wire. Tack welding prohibited. Coat bolt threads and nuts with heavy coat of clean grease. Anchor bolt location tolerance: 1/16 IN. Provide steel templates for all column anchor bolts.

Z. Install bollards in concrete as detailed. Fill pipe with concrete and round off at top.

AA. Provide abrasive stair nosing at each concrete stair landing having metal stair structure attaching to the concrete landing.
1. Center stair nosings in stair width.

BB. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor. Keep screw holes clean and ready to receive screws.

CC. Attach grating to end and intermediate supports with grating saddle clips and bolts.
1. Maximum spacing: 2 FT OC with minimum of two per side.

DD. Coat aluminum surfaces in contact with dissimilar materials in accordance with Section 09905.

EE. Repair damaged galvanized surfaces in accordance with ASTM A780.
1. Prepare damaged surfaces by abrasive blasting or power sanding.
2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

3.3 FIELD QUALITY CONTROL

A. Testing Agency responsibilities are described in Article 2.5.

B. Tolerances (unless otherwise noted on the Drawings):
1. Frame placement, after assembly and before welding or tightening.
a. Deviation from plumb, level and alignment: 1 in 500, maximum.
b. Displacement of centerlines of columns: 1/2 IN maximum, each side of centerline location shown on Drawings.

3.4 CLEANING

A. After erection, installation or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings specified in Section 09905.

END OF SECTION

1

SECTION 05522
ALUMINUM RAILINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Aluminum handrail, stair rail and guardrail.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
   2. Division 1 - General Requirements.
   3. Section 05505 - Metal Fabrications.
   4. Section 09905 - Painting and Protective Coatings.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The Aluminum Association (AA):
      a. Aluminum Design Manual.
      b. 45, Designation System For Aluminum Finishes.
         1) 611, Voluntary Specification for Anodized Architectural Aluminum.
   2. American Society of Mechanical Engineer (ASME):
      a. Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   3. ASTM International (ASTM):
      a. A320, Standard Specification for Alloy-Steel Bolting Materials for Low-Temperature Service.
      b. B108, Standard Specification for Aluminum-Alloy Permanent Mold Castings.
      c. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
      d. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes and Tubes.
      e. B247, Standard Specification for Aluminum and Aluminum-Alloy Die Forgings, Hand Forgings, and Rolled Ring Forgings.
      f. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
      g. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
   4. American Welding Society (AWS):
      a. C5.5, Recommended Practices for Gas Tungsten Arc Welding.
      b. D1.2, Structural Welding Code Aluminum.
   5. National Association of Architectural Metal Manufacturers (NAAMM):
      a. ANSI/NAAMM AMP521, Pipe Railing Manual.
   6. U. S. Department of Labor, Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, OSHA Safety and Health Standards for General Industry (referred to herein as OSHA standards).
   7. Building code:
      a. International Code Conference (ICC):
         1) International Building Code and associated standards, 2000 Edition, including all City of Kerrville, Texas, 2000 IBC amendments, referred to herein as Building Code.

B. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS and ASME Section IX.

1.3 DEFINITIONS

A. Guardrail: A system of building components located near the open sides of elevated walking surfaces for the purpose of minimizing the possibility of an accidental fall from the walking surface to the lower level.

B. Handrail: A railing provided for grasping with the hand for support.

C. Railing: A generic term referring to guardrail, handrail and/or stair rails.

D. Stair Rail: A guardrail, installed at the open side of stairways with either a handrail mounted to the inside face of the guardrail, or where allowed by applicable codes, with the top rail mounted at handrail height and serving the function of a handrail.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 01340.
   2. Fabrication and/or layout drawings:
      a. Plan showing profile, location, sections and details of each railing.
      b. Type and details of anchorage.
      c. Location and type of expansion joints.
      d. Materials of construction , shop coatings and all third-party accessories.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation details.
   4. Certification that railings have been designed and fabricated to meet the loading requirements specified.

B. Miscellaneous Submittals:
   1. See Section 01340.
   2. Certification of welders and welding procedures indicating compliance with AWS requirements.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver and handle railings to preclude damage.

B. Store railings on skids, keep free of dirt and other foreign matter which will damage railings or finish and protect against corrosion.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Welded railing systems:
      a. Any manufacturer meeting this Specification.

B. Submit requests for substitutions in accordance with Specification Section 01640.

2.2 MATERIALS

A. Alloy 6061-T6, 32,000 psi tensile yield strength minimum.
   1. ASTM B209 for sheets and plates.
   2. ASTM B221 and ASTM B308 for shapes - beams, channels, angles, tees, and zees.
   3. ASTM B247 for forgings.

B. Alloy 6063-T5 or T6, 15,000 psi tensile yield strength minimum.
   1. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.

C. Cast Fittings: Aluminum, ASTM B108.

D. Shims: Aluminum of same alloy as component being shimmed.

E. Fasteners: See Section 05505.

F. Expansion and Adhesive Anchors: See Section 05505.

G. Electrodes for Welding:
   1. Aluminum: AWS D1.2.
   2. Filler alloy 5356 or 4043.

2.3 FABRICATION

A. General:
   1. Verify field conditions and dimensions prior to fabrication.
   2. For fabrication of items which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
      a. Remove blemishes by grinding and buffing or by welding and grinding, prior to cleaning, treating and application of surface finishes.
   3. Form exposed work with smooth, short radius bends, accurate angles and straight edges.
      a. Ease exposed edges to a radius of approximately 1/32 IN.
      b. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
      c. Drill or punch holes with smooth edges.
   4. Form exposed connections with flush, smooth, hairline joints, using stainless steel or aluminum splice locks to splice sections together or by welding. Top rail splices and expansion joints shall be located within 8 IN of post or other support.
      a. Ease the edges of top rail splices and expansion joints and remove all burrs left from cutting.
   5. Provide for anchorage of type indicated on Drawings or as required by field conditions.
      a. Drill or punch holes with smooth edges.
   6. Handrails and guardrails shall be designed to resist a load of 50 PLF applied in any direction at the top of the handrail or guardrail.
   7. Handrails and guardrails shall be designed to resist a single concentrated load of 200 LB applied in any direction at any point along the top of the handrail or guardrail.
   8. Loading conditions need not be assumed to act concurrently.
   9. Intermediate rails and filler panels shall be designed to withstand a horizontally applied load of 50 LB on an area not to exceed 1 SF including openings and space between rails.
   10. Reactions due to this loading are not required to be superimposed with those of either preceding paragraph.
   11. Custom fabricate railings to dimensions and profiles indicated.
      a. Fabricate handrail mounted to wall or to guardrail vertical posts using minimum 1-1/4 IN nominal DIA Schedule 40 pipe.
      b. Fabricate all guardrail top rails using minimum 2 IN nominal DIA Schedule 40 pipe.
      c. Fabricate all guardrail vertical posts using minimum 2 IN nominal DIA Schedule 40 pipe.
         1) Guardrail vertical posts that are to be side-bracket mounted to a vertical concrete surface or metal structure shall use Alloy 6063-T6.
      d. All intermediate rails shall be fabricated using minimum 1-1/2 IN nominal DIA Schedule 40 pipe.
         1) Where details are not indicated, set horizontal rails to requirements of the Building Code,and/or OSHA whichever requires the more restrictive design.
      e. Base plate for vertical guardrail posts mounted to top of concrete surface:
         1) 3/8 x 6 x 6 IN square plate welded to the vertical post.
         2) Predrilled to accept four anchors.
         3) Provide a 2 IN DIA x 8 IN long solid aluminum rod welded to the base plate.

4) Fit the vertical post over the solid rod and weld the post to the base plate

f. Base plate for vertical guardrail post mounted to metal structure:
   1) 3/8 x 2-1/2 x 8 IN plate welded to the vertical post.
   2) Predrilled to accept two fasteners.
   3) Provide a 2 IN DIA x 8 IN long solid aluminum rod welded to the base plate.
   4) Fit the vertical post over the solid rod and weld the post to the base plate

g. Mounting bracket for vertical guardrail post mounted to vertical concrete surface or web of metal structural member:
   1) Pair of 3/8 IN angles or bent plates welded to vertical posts.
   2) Predrilled to accept two fasteners each.
   3) Weld angles or bent plates to vertical posts.

h. Provide 3/8 IN x 4 IN flat bar toeboards or 1/4 IN minimum thickness x 4 IN high extruded toeboard with stiffener ribs on back side at all elevated walkways, platforms and stair landings, and where indicated on the Drawings or required by OSHA Standards.
   1) Clearance between bottom of toeboard and walking surface shall not exceed 1/4 IN.

12. Fit exposed ends of guardrails and handrails with solid terminations.
    a. Return ends of handrail to wall, but do not attach to wall.
    b. Where guardrail terminates at a wall provide a vertical post located 4 IN off the wall to center of post.
13. Preassemble items in shop to greatest extent possible to minimize field splicing and assembly of units at project site.

B. Finish:
   1. Architectural class 1 coating per AA 45:
      a. AA-M12C22A41 clear anodized

C. Welded Railing Fabrication:
   1. All welding to be continuous in accordance with AWS C5.5 and AWS D1.2.
      a. All welded railing joints shall have full penetration welds unless noted otherwise.
   2. All exposed welds to be ground and buffed smooth and flush to match and blend with adjoining surfaces.
   3. No ragged edges, surface defects, or undercutting of adjoining surfaces will be accepted.
   4. Finishing joints with filler is not acceptable.

D. Install weeps to drain water from hollow sections of railing at exterior and high humidity conditions.
   1. Drill 1/4 IN weep hole in railings closed at bottom:
      a. 1 IN above walkway surface at bottom of posts set in concrete.
      b. 1 IN above solid aluminum rod at posts having base plate.
      c. At low point of intermediate rails.
      d. Do not drill weep holes:
         1) In bottom of base plate.

E. Expansion Joints:
   1. Allow thermal expansion and contraction of railing while still meeting design loading requirements.
   2. Where railing bridges across an expansion joint in the building/structure, fabricator is to provide an expansion on the railing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install handrails and guardrails to meet loading requirements of the Building Code.

B. Provide welded type railings.

C. Install products in accordance with manufacturer's instructions.

D. Set work accurately in location, alignment and elevation; plumb, level and true. Measure from established lines and items which are to be built into concrete, masonry or similar construction.

E. Align railings prior to securing in place to assure proper matching at butting and expansion joints and correct alignment throughout their length.
   1. Space vertical posts as required by loading requirements but not more than 4 FT on center.
   2. Space handrail brackets as required by loading requirements but not more than 4 FT on center.
   3. Provide shims as required.

F. Install proper sized expansion joints based on temperature at time of installation and differential coefficient of expansion of materials in all railings as recommended by manufacturer. Joints to be designed to allow expansion and contraction of railing and still meet design loads required.

G. Attach handrails to walls or guardrail with brackets designed for condition:
   1. Provide brackets which provide a minimum 1-1/2 IN clearance between handrail and nearest obstruction.
      a. Provide minimum 2-1/4 IN clearance for handrails in stairways.
      b. Handrails shall not project more than 4-1/2 IN into required stairway width.
   2. Anchor handrail brackets to concrete or masonry walls with 1/2 IN stainless steel adhesive anchors with stainless steel hex head bolts.

H. Anchor railings to concrete with minimum 1/2 IN stainless steel adhesive anchors with stainless steel bolts, nuts and washers unless noted otherwise in the Contract documents.
   1. Where exposed, bolts shall extend minimum 1/2 IN and maximum 3/4 IN above the top nut.
      a. If bolts are cut off to required height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nut.
      b. Bevel the top of the bolt after cutting to provide a smooth surface.

I. Anchor railings to metal structure with minimum 3/4 IN stainless steel bolts, nuts and washers.

J. Coat aluminum in contact with dissimilar metal or concrete in accordance with Section 09905.

K. Provide railings as required for stair construction identified in Specification Section 05505.

END OF SECTION

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