1. SCOPE

1.1 This specification governs the detailing, material supply, fabrication, delivery, and erection of structural and miscellaneous steel.

2. REFERENCE CODES, SPECIFICATIONS, AND STANDARDS

2.1 All work shall be in accordance with this specification and the requirements of the latest editions of the following codes, specifications, and standards except as noted otherwise on the design drawings or within this specification.

2.2 American Institute of Steel Construction (AISC)

2.2.1 Manual of Steel Construction, "Allowable Stress Design."

2.2.2 Specification for "Structural Steel Buildings."

2.2.3 "Code of Standard Practice for Steel Buildings and Bridges."

2.2.4 Specification for "Structural Joints Using ASTM A325 or A490 Bolts."

2.3 American Welding Society (AWS)

2.3.1 "Structural Welding Code," D1.1.

2.4 American Society for Testing and Materials (ASTM)

2.4.1 ASTM A27, "Standard Specification for Steel Castings, Carbon, For General Application"

2.4.2 ASTM A36, "Standard Specification for Structural Steel."

2.4.3 ASTM A53, "Standard Specification for Pipe, Steel, Black and Hot Dipped, Zinc-coated, Welded and Seamless."


2.4.5 ASTM A143, "Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement."

2.4.6 ASTM A153, "Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware."
### Structural and Miscellaneous Steel

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2.4.23 ASTM F436, "Standard Specification for Hardened Steel Washers."

2.4.24 ASTM F959, "Standard Specification for Compressive Washer-Type Direct Tension Indicators for use with Structural Fasteners."

3. MATERIALS

All materials shall conform to that listed below, unless noted otherwise on the drawings. All material shall be new.

3.1 Steels

3.1.1 All structural steel shapes, plates, and bars shall conform to ASTM A36.

3.1.2 All steel pipe and pipe columns shall conform to ASTM A53, Grade B.

3.1.3 All structural steel tubing shall conform to ASTM A500, Grade B.

3.1.4 High strength bolts shall be 3/4” diameter unless noted otherwise on the drawings, and conform to ASTM A325 or ASTM A490. All high strength bolts are to be new and not previously used.

3.1.5 Machine bolts or common bolts shall conform to ASTM A307, Grade A.

3.1.6 Anchor bolts embedded in concrete or concrete masonry shall conform to ASTM A36.

3.1.7 All nuts shall conform to A563, Grade A, for A307 or A36 bolts. Nuts for A325 and A490 bolts shall conform to A563, Grade DH, heavy hex or A194, Grade ZH, heavy hex.

3.1.8 All washers shall conform to ASTM F436.

3.1.9 Special fasteners, such as self-locking screw threads or self-locking nuts, shall be as specified on the drawings or as approved by the Engineer.

3.1.10 Welding electrodes shall be E70XX.
3.1.11 Weldable steel stud connectors shall be of the automatic end-weld type conforming to AWS1.1

3.1.12 Pipe handrail shall conform to ASTM A120.

3.1.13 All high strength bolts shall be installed using the turn-of-nut method, calibrated wrench, or compressible washer type direct tension indicators conforming to ASTM F-959. The installation of the direct tension indicators shall follow manufacturer’s instructions for the minimum tension requirements for fully-pretensioned bearing connections as listed in Table 4, page 5-274 of the AISC Manual of Steel Construction.

4. DRAWINGS AND SUBMITTALS

4.1 Shop and Erection Drawings

4.1.1 Information

- Drawings shall include all shop and erection details including cut, copes, connections, holes, bolts, and welds in structural steel. All welds, both shop and field, shall be indicated by standard welding symbols conforming to the American Welding Society. Drawings shall show the size, length, and type of each weld per AWS A2.0, "Standard Welding Symbols." Where areas are on "hold" on the Engineer's design drawings, materials shall not be detailed until the "hold" is removed by the Engineer.

- The drawings shall reference the engineers applicable design drawings and include all information required for fabrication and erection.

- Orientation shall be the same as the Engineer's design drawings.

4.1.2 Approval

Approval by the Engineer of fabricator’s drawings shall not relieve the fabricator of responsibility for accuracy of dimensions or adequacy of design. Only checked drawings will be accepted.

4.1.3 Material shall not be fabricated or delivered prior to the Engineer's review being completed, and the indicated revisions, if any, have been made to the shop drawings.
4.1.4 Reproducible
One (1) reproducible of each of the Fabricator’s shop drawings shall be forwarded to the Engineer when they are issued to the shop for fabrication. Copy to Owner.

4.2 Submittals

4.2.1 A certificate of conformance to this specification shall be submitted to the Engineer with each delivery of fabricated material.

4.2.2 A test report for the last completed set of mechanical tests for each size nut shall be submitted to the Engineer in each delivery.

4.2.3 One (1) copy of the Manufacturer’s instructions for installation and inspections of load indicators shall be submitted to the Engineer and one (1) copy shall be submitted to the Erector. Each lot of load indicators will be subject to verification testing by the erector by use of a direct tension indicator. Any failure of a proper load indicator gap to produce the minimum specified tension shall constitute a “warehouse hold” on that lot of load indicators.

4.2.4 Reports of nondestructive testing shall be submitted to the Engineer. Copy to Owner.

4.2.5 Certified mill test reports shall be furnished to the Engineer to verify that materials meet applicable specification.

5. FABRICATION

5.1 Assembly
Shop fabricated structural steel shall be assembled into units as large as possible consistent with shipping or galvanizing limitations.

5.2 Fitting
Radius for re-entrant flame cuts shall be 3/4” minimum except in members smaller than 8”. Shearing, flame cutting, and chipping shall be done carefully and accurately. Sole plates of beams and girders shall have full contact with the flanges. Stiffeners shall be fitted neatly between the flanges or girders and, where tight fits are required to transmit bearing, the ends of stiffeners shall be milled or ground to secure an even bearing against the flange angles. The clearance between the ends of spliced webs shall not exceed 1/4”.
5.3 **Draw**
Allowance shall be made for draw in all tension bracing longer than 10'-0".

5.4 **Holes**
Holes shall be cut, stub-drilled and reamed or punched at right angles to the surface of the metal and shall not be made or enlarged by burning. Holes in base or bearing plates shall be drilled. Holes shall be clean-cut without torn or ragged edges. Outside burrs resulting from drilling or reaming operations shall be removed with a tool making a 1/16" bevel.

5.5 **Erection Clips**
Fabricator shall furnish and install erection clips for fit-up of field-welded connections.

5.6 **Existing Steel**
Connections to existing steel shall be field welded unless otherwise specified.

5.7 **Fabrication Tolerances**
Fabrication tolerances shall conform to AISC "Code of Standard Practice for Steel Buildings and Bridges."

5.8 **Erection Marks**

5.8.1 **Building Structure Identification**
When projects involve more than one building structure, Fabricator shall apply a separate shop order number to each building structure or otherwise suitably identify the steel for each building structure in the project.

5.8.2 **System of Marking**
The system used shall be fabricator’s standard practice unless otherwise specified herein.

5.8.3 **Method of Marking**
Shop-painted steel shall be legibly marked with paint of a color different from that used for shop painting. Galvanized steel shall be marked with metal tags wired to each member or with 1" high metal die-stamped letters legibly imprinted prior to galvanizing.

5.9 **Specific Details**

5.9.1 **Gusset and stiffener plates** shall be a minimum of 3/8" thick.
5.9.2 Columns shall have full bearing at splices and at baseplates.

5.9.3 Axially loaded members shall meet at a point so as to preclude induced bending moments into the members. If this is not practicable, provisions shall be made for induced bending stresses.

5.10 Materials Preparation

5.10.1 All material shall have clean surfaces before fabricating. Joint surfaces, including those adjacent to washers, shall be free of dirt, loose scale, burrs, or other defects that would prevent solid seating of all parts.

5.10.2 All members shall be free of twists, bends, or loose joints.

5.10.3 Bolt holes shall be drilled or punched 1/16" larger than the nominal diameter of the bolt unless noted on design drawings.

5.10.4 Column baseplates exceeding 15/16" in thickness shall be thermal cut by machine to the size specified.

5.10.5 All beams shall be fabricated with natural camber up.

5.10.6 Welding shall be in accordance with AWS D1.1.

- Welders, tackers, and welding operators shall hold current certification in accordance with AWS D1.1 to perform the type of welding required.
- The technique of welding employed, the appearance, and quality of welds made and methods used in correcting defective work shall conform to AWS D1.1.
- Except for stud connectors, welds shall be either by manual shielded metal-arc welding, submerged arc welding, or flux cored arc welding processes. Electrodes shall conform to AWS A5.1 or A5.5, E70 series, for manual shielded metal-arc welding. For submerged arc welding, electrodes and granular flux shall conform to AWS 5.17, F7X-EXXX Classification. For flux cored arc welding, electrodes, and flux shall conform to AWS A5.20, E70 T-X series.
- Tack welds which are not incorporated into the final weld and inadvertent arc strikes shall be removed and ground smooth.
- Welding run-off tabs shall be cut off and ground smooth at the edge of the finished member.
Stud connectors shall be installed in accordance with and meet the requirements of AWS D.1.1.

In addition to 100% visual inspection, the fabricator shall inspect 10% of all shop-welded connections using either dye penetrant inspection in accordance with the procedure and technique set forth in ASTM E165 or magnetic particle inspection in accordance with the procedure and technique set forth in ASTM E709. Any additional testing, as noted on the design drawings, shall also be provided by the Fabricator.

When field welding is specified on the Engineer's drawings, the Fabricator shall furnish and install suitable erection supports.

6. CONNECTIONS

6.1 The design of AISC standard connections not specifically detailed on the drawings shall be the responsibility of the Fabricator and subject to approval of the Engineer.

6.2 Connections for main members, including all bracing, shall employ high strength bolts or equivalent welds. Bearing type connections shall be used except that shear connections subjected to stress reversal, severe stress fluctuation, impact or vibration, or where slippage would be undesirable shall be friction type as specified on the drawing. Purlins, girts, and other auxiliary member connections may employ machine or common bolts. Butt welds shall have full penetration and all abutting joint surfaces shall be sealed with a 1/8" weld. The minimum diameter of bolts shall be 3/4" except when the sizes of the members will not permit, in which case the largest bolt diameter permissible shall be used.

6.3 Beams

Beam connections shall be designed for the loads indicated on the drawings. If no loads are indicated, connection configurations shall be as outlined in Tables II A through C, Table III or Table IV of Part 4 of the AISC Manual of Steel Construction with connection length "L" or "L'" and the number of fasteners "M" corresponding to the maximum possible for the beams depth.

6.4 Axially Loaded Bracing

6.4.1 Vertical Bracing

Minimum connections for axially loaded bracing members shall be designed for the loads shown on the drawings or the allowable tensile capacity of the member where the
loads are not shown. No fewer than two bolts may be used in any connection.

6.4.2 Horizontal Bracing
Connections for horizontal bracing shall be the greater of the following: one-half the allowable tensile capacity of the brace or the forces as shown on the drawings; no fewer than two bolts may be used in any connection.

6.4.3 All axially stressed members shall have their gravity axis meet at a common point, if practicable. Otherwise, the member and connection shall be designed to withstand moments caused by the eccentricities.

6.5 Shop
Shop connections shall be welded but may utilize high strength bolts where welding is uneconomical or impractical, subject to approval by the Engineer.

6.6 Field
Field connections shall be bolted unless otherwise indicated on the drawings.

6.7 Fabricator shall furnish two percent (2%) additional bolts, nuts, washers, load indicators, and grating saddle clips to allow for loss during erection.

7. MISCELLANEOUS STEEL

7.1 This section covers the materials, detailing, fabrication, and erection of all miscellaneous steel items. The following list of items is not intended to be all-inclusive but to illustrate major categories.

7.1.1 Fabricated steel frames for openings and miscellaneous fabricated steel access doors.

7.1.2 Handrails, toeplates, grating, floor plate, treads, nosing, ladders, and cages, etc.

7.1.3 Ceiling framing smaller than 3" together with hangers and fastenings when shown on structural drawings.

7.1.4 Guards, steel thresholds, etc.

7.2 Materials
Items shall be fabricated from unused mill or foundry products conforming to the following minimum requirements:
Structural and Miscellaneous Steel

7.2.1 Hot Rolled Sheet: A245, Grade D. Hot Rolled Strip: A303, Grade C and A283 Grade, C for cold formed or bent plate.

7.2.2 Cast Steel: ASTM A27, Class E.

7.2.3 Steel Forgings: ASTM A235, Class E.

7.2.4 Structural Shapes and Steel Plates: ASTM A36.

7.2.5 Steel Pipe: Seamless or welded ASTM A53, Grade B.

7.2.6 Steel Tubing: ASTM A500, Grade B.

7.2.7 Connectors: ASTM A307, A325, or A490; AWS E-60, E-70, SAW-1 or SAW-2, Electrodes.

7.3 Fabrication

7.3.1 Metal Grating and Treads

• Grating Type
  All grating shall be non-serrated welded grating 1-1/4" by 3/16" bearing bars at 1-3/16" centers and cross bars at 4" centers unless noted otherwise on design drawings. Grating shall be galvanized.

• Stair Treads
  Stair treads shall be coated to match grating (galvanized/painted) serrated grating with nonslip coated 1/4" checker plate with 1-3/8" by 1-3/8" nosings. The treads shall be fabricated from serrated, welded grating having 1-1/4" by 3/16" bearing bars at 1-3/16" centers and cross bars at 4" centers unless noted otherwise on design drawings. Stair treads in process areas shall be painted.
  A nonslip nosing shall be provided on platforms at the head of stairs.

• Banding
  Banding bars shall be of the same thickness as the bearing bars to which they are welded. The following locations shall be trim-banded except at cutouts having unsupported bearing bars which shall be load-carrying banded.

  Open ends of grating at head of ladder approach to platform.
  All dimensioned openings in grating.
All hinged sections.

- **Openings**
  Openings dimensioned on the design drawings shall be provided by the fabricator. Undimensioned openings shall be cut in the field by the erector.

- **Fasteners**
  Grating shall be removable unless otherwise specified on the design drawings.
  Grating fasteners for painted steel shall be saddle clip anchors secured to the supporting steel by gun-welded studs. Grating fasteners for galvanized steel shall be galvanized saddle clip anchors secured to the supporting steel by powder tool fastened studs or by self-drilling and tapping studs.

### 7.3.2 Floor Plate

- **Type**
  All floor plate is to have an embossed diamond surface and be 1/4" in thickness unless noted otherwise on drawings.

- **Connections**
  Removable floor plate shall be fabricated for attachment to supporting steel with 1/2" diameter, countersunk flathead, cadmium-plated machine bolts, spaced not more than 2'-6" on centers, with a minimum of 4 bolts per panel. Fixed floor plate shall be plug welded to supporting steel with 1/2" diameter plug welds at a maximum spacing of 2' centers with a minimum of four welds per panel.

- **Removable Floor Plate**
  Removable floor plate sections shall be indicated on the drawings and shall be fabricated with two 1" diameter lifting holes located at diagonally opposite corners. Burrs and rough edges shall be ground smooth.

- **Openings**
  Holes for penetrations through the plate shall be fabricated in the shop and shall be provided with 1/4" kickplates projecting 4" above the plate. Removable floor plate shall be split around all holes into easily removable sections.
• **Finish**  
  All floor plate shall be free from sharp edges, flat without bends or dents, and painted per project specifications.

7.3.3 **Handrail**  
• **Fabrication**  
  All handrail shall conform to applicable codes, be free of burrs or sharp edges, and be fabricated and erected as shown on drawing.  
• **Finish**  
  All handrail and kickplate shall be primed and painted safety yellow per project specifications.

7.3.4 **Embeds**  
• **Loose Lintels**  
  Loose lintels shall be fabricated in lengths to provide 8" bearing on each end. When bolted to concrete, extend lintels 4" beyond the masonry opening on each side. When composed of two or more sections, weld the sections together using pipe separators when required.  
• **Shelf Angles**  
  Where indicated to be installed by use of adjustable inserts, provide horizontal slots in the shelf angles at the spacings shown for inserts. Miter corners for welding. Allow 1/4" in 20' for expansion.

• **Curb Angles**  
• **Others**

**8. COATING**

8.1 The type of coating (painting or galvanizing) shall be indicated on the drawings.

8.2 **Galvanized**  
Galvanizing of structural steel shall be done in accordance with standard specification for zinc coating (hot-dip ASTM designation A123, A153, A143, and A386 latest revision (minimum of 2 ounces per square foot). Galvanized coatings shall not be allowed within process areas.
8.3 Painted
Surface preparation and paint shall be as shown on the drawings or in accordance with the "Specification for Painting of Structural and Miscellaneous Steel".

9. INSPECTION AND TESTING

9.1 Shop QA/QC
The Fabricator shall establish and perform a shop inspection system for sufficient inspections and tests to assure conformance to contract requirements. This Quality Control Program shall be submitted to the Engineer prior to fabrication. The Engineer reserves the right of inspection for its representative and for its client during fabrication.

9.2 Owner may perform non-destructive (visual and dye-penetrant, magnetic particle, ultrasonic, or radiographic) testing to ensure quality of welds. Should inspection reveal that the welds of any welder contain defects which may affect the strength or durability of the structure, such welder may be permanently removed from the work, and any such welds shall be repaired to satisfaction of Engineer at no additional cost to the Owner.

9.3 Where specified and to the extent shown on the drawings, non-destructive testing shall be performed and documented in the shop by the Fabricator. All results of such testing shall be submitted to the Engineer for review.

10. SHIPPING AND DELIVERY

10.1 The Fabricator shall deliver the materials to the project site in accordance with the detailing and fabrication/delivery schedule.

10.2 Materials shall be loaded, cribbed, and braced to prevent movement on the transport vehicle during shipment, which may result in damage.

10.3 The Erector shall visually inspect deliveries for damage prior to unloading. Any damage shall be acknowledged by the Fabricator's delivery agent.

10.4 Shipping lists shall accompany each shipment of steel.

10.5 Small pieces shall be bundled with steel bands to prevent damage during shipment and to facilitate unloading.

10.6 Sufficient structural fasteners (bolts, nuts, washers) shall accompany each shipment of steel.
11. **ERECITION**

Splices and field connections shall be made with high strength bolts unless machine bolts are specifically indicated.

11.1 **Bases**

Bases and bearing plates may be attached or loose. Base plates and bearing plates shall generally be supported and aligned on steel wedges or shims. After the supported members have been plumbed and properly positioned and the anchor nuts tightened, the entire bearing area under the plate shall be filled with a non-shrink grout in accordance with the "Specification for Bonding and Grouting".

11.2 **Assembly**

After assembly, the various members forming parts of a completed frame or structure shall be aligned and adjusted accurately before being permanently fastened. Tolerances shall conform to the AISC "Code of Standard Practice." Fastening of splices of compression members shall be done after the abutting surfaces have been brought completely into contact. Bearing surfaces and surfaces that will be in permanent contact shall be cleaned before the members are assembled. As erection progresses, the work shall be securely fastened or braced to resist all dead load, wind, and erection stresses. Unless removal is required, all erection bolts used in welded construction may be tightened securely and left in place. If erection bolts are removed, the holes shall be filled with plug welds. Holes shall not be enlarged more than 1/16" greater than the specified hole size without approval of the Engineer.

11.3 **Driftpins**

Driftpins may be used only to bring together or align the several parts and shall not be used in such manner as to distort or damage the metal.

11.4 **Storage**

Structural material, either plain or fabricated, shall be stored above the ground upon platforms, skids, or other supports. Material shall be kept free from dirt, grease, and other foreign matter and shall be protected from corrosion.

11.5 **Damage to Coatings**

Any damage to coatings sustained during erection shall be repaired by the Erector at the Erector's expense.