

## DIVISION SFD

### STEEL STRUCTURES (FABRICATION WITHOUT DETAILING)

#### SFD.1 SCOPE

This DIVISION, along with DIVISION GQ – GENERAL REQUIREMENTS, covers the design, detailing, shop fabrication, surface preparation, galvanizing, and related items necessary to complete the steel structures, as indicated on the Owner Furnished Fabrication Drawings and as specified herein. It is the intent of this Division to have the equipment designed, manufactured, tested, and delivered in accordance with the most advanced and modern technical and commercial practice(s). Equipment furnished shall be complete and suitable in all respects for the service indicated, despite the omission of specific reference to any minor component part.

#### SFD.2 GENERAL

- A. The work to be provided by the Fabricator under this Division shall include the following:
1. Steel structures fabricated and furnished, as required in the Contract and specified herein.
  2. Schedules, manufacturing and quality procedures, and other information and documents specified herein.
  3. Delivery of the equipment to the specified delivery site.
- B. The following work will be provided by others:
1. Steel structure layout.
  2. Detailed Steel Erection Drawings and Fabrication Shop Drawings.
  3. Foundation design and placement.
  4. Unloading of the structures and equipment at the job site.
  5. Assembly and erection.
- C. Codes and Standards
1. Work provided under this Division shall be in strict conformance with the latest edition and latest addenda thereto as of the time the work is performed and of the applicable codes, standards, regulation procedures, and tests of the organizations listed below.
  2. Design, detailing, and fabrication of the structures shall conform to the requirements of the following:

AISC	American Institute of Steel Construction, Specification for Structural Steel Buildings, AISC 360
ASCE	American Society of Civil Engineers
	1) Standard 48 Design of Steel Transmission Pole Structures
	2) Manuals and Reports on Engineering Practice No. 113, Substation Structure Design Guide
ASTM	American Society for Testing and Materials, various standards
AWS	American Welding Society, Structural Welding Code, AWS D1.1
  3. Structures shall be designed, fabricated, assembled, and tested in conformance with the latest revision(s) of the following:

AISC	American Institute of Steel Construction, Steel Construction Manual
ASCE	American Society of Civil Engineers
	1) Standard 10 Design of Latticed Steel Transmission Structures
	2) Standard 48 Design of Steel Transmission Pole Structures
ASME	American Society of Mechanical Engineers
	1) B18.2.1 Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series)

	2)	B18.2.2 Nuts for General Applications: Machine Screw Nuts, Hex, Square, Hex Flange, and Coupling Nuts (Inch Series)
ASTM		American Society for Testing and Materials
	1)	A6 General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
	2)	A36 Standard Specification for Carbon Structural Steel
	3)	A90 Standard Test Method for Weight [Mass] of Coating on Iron and Steel Articles with Zinc or Zinc-Alloy Coatings
	4)	A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
	5)	A143 Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
	6)	A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware
	7)	A239 Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles
	8)	A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 ksi Tensile Strength
	9)	A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105ksi Minimum Tensile Strength
	10)	A370 Standard Test Methods and Definitions for Mechanical Testing of Steel Products
	11)	A384 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies
	12)	A394 Standard Specification for Steel Transmission Tower Bolts, Zinc-Coated and Bare
	13)	A449 Standard Specification for Hex Cap Screws, Bolts and Studs, Steel, Heat Treated, 120/105/90 ksi Minimum Tensile Strength, General Use
	14)	A490 Standard Specification for Heat-Treated Steel Structural Bolts, 150 ksi Minimum Tensile Strength
	15)	A563 Standard Specification for Carbon and Alloy Steel Nuts
	16)	A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel
	17)	E376 Standard Practice for Measuring Coating Thickness by Magnetic-Field or Eddy-Current (Electromagnetic) Test Methods
AWS		American Welding Society, Structural Welding Code D1.1

#### D. Fabricator Requirements

1. Fabricators of steel structures shall be subject to the approval of the Engineer and Owner and shall have the following qualifications:
  - a. Regularly engaged in the fabrication of substation structures.
  - b. Previously designed and fabricated substation structures of the general types specified.
  - c. Qualified design staff regularly devoted to the design and detailing of substation structures.
2. Fabricators of steel structures shall have a working familiarity with RUS Bulletin 1724E-300, June 2001 Edition, Design Guide for Rural Substations, Chapter 7 – Structures.

#### SFD.3 DESIGN AND DETAILS

- A. The Design Drawings will show the required structures.
- B. For previously designed structures, the Fabricator shall use existing Shop Drawings only after making any modifications shown on the Drawings and checking and verifying all dimensions for

- fit. The Fabricator may re-detail these structures to suit standard manufacturing practices. The Fabricator shall prepare complete Shop Details, Materials List(s), and Drawings for any additional or revised requirements shown by the Engineer's notations on the existing Drawings. All costs for checking, verifying, re-detailing, and additional details shall be included in the appropriate bid items.
- C. For structures designed by the Engineer, the following shall apply:
    - 1. Drawings will show required dimensions, minimum section sizes, and plate thickness.
    - 2. Variations in connection type and equipment support details to suit the Fabricator's standard practice may be acceptable.
  - D. For structures requiring Fabricator design, detailed Drawings and data necessary for the design, testing, assembly, erection, and operation of all structures furnished shall be provided, including, but not limited to, the following:
    - 1. Structure Calculations
      - a. The horizontal and vertical deflection as measured from the horizontal and vertical axis for each specified loading condition at each level of wire attachment.
      - b. Complete calculations used in the final design of each structure under the maximum loading criteria.
      - c. Calculated groundline and point-of-fixity reactions due to the tip loadings, including shear, moment, and axial reactions.
    - 2. Foundation Loading Diagrams
      - a. The simultaneous shear in each direction, simultaneous moment in each direction, and vertical load at each structure's base plate or groundline for each specified loading condition.
      - b. The Fabricator shall state whether indicated loads are working loads or multiplied by an overload factor. If overload factors are applied, the magnitude shall be defined and data and references furnished pertinent to these factors.
    - 3. Items D.2.a. through D.2.b. shall be included in the Bid Proposal.
    - 4. Structural Drawings
      - a. Code markings shall correspond with identical markings stamped on the individual fabricated steel members and assemblies (before galvanizing).
      - b. Complete Fabrication and Erection Drawings for each structure shall include complete dimensions.
    - 5. All final calculations and Drawings shall be performed and sealed by a registered Professional Engineer in the jurisdiction that the Project is located.
      - a. Final designs must be approved by the Owner or the Owner's representative before materials ordering and fabrication, which prior to approval shall be at the Supplier's risk. It is understood that award of the Contract shall not constitute acceptance of any design calculations submitted with the Bid Proposal. The quoted price shall not change if corrections are required to the final structure designs due to the Manufacturer's errors, omissions, or misinterpretations of the Specifications. Approval of the Drawings and calculations by the Owner or the Owner's representative will not relieve the Supplier of any responsibility for the adequacy of the design, correctness of the dimensions, details on the Drawings, and proper fit of the parts.
      - b. All final Drawings shall become the property of the Owner who shall have full rights to reproduce Drawings and use them as the Owner sees fit.
  - E. Dimensions
    - 1. Depending on specific equipment ordered, the dimensions may vary slightly, and the Fabricator may make slight alterations, as necessary, to make adjustable parts fit the fixed parts.
    - 2. The Fabricator shall verify all dimensions with the Engineer before commencing work.
  - F. Straight anchor bolts with heavy hex nut anchorage shall be designed in accordance with ACI 318, Appendix D. Alternate, rational, design procedures for hooked anchor bolts shall be approved by the Engineer.

- G. Switch support structures are detailed for specific switches in the Design Drawings. Group operated switches have not yet been purchased for the Project, however, and actual mounting and operating details for switches purchased may therefore differ from those shown on the provided Shop Drawings. The Engineer may redesign switch mounting details, as required, to support actual switches to be used, which may also include minor adjustment(s) needed to the structure height to maintain design bus heights. If necessary, the Engineer shall furnish to the Fabricator the revised Steel Details Drawings.
- H. The galvanized coating shown on all Drawings shall be 5 mil thickness or 3 ounces per square foot.
- I. A galvanized coating shall be provided that is continuous, adherent, and free of any uncoated spots, blisters, chemical flux, and projections which will interfere with the intended use of the structure and assemblies. Holes shall be clean and free of superfluous spelter.

#### SFD.4 STEEL FABRICATION

- A. Structural W-, M-, S-, and HP-shapes and any other shapes made from those shapes shall conform to ASTM A992 50 ksi steel. Angles, L-shapes and Channels, and C- and MC-shapes shall be ASTM A36 steel. Square and rectangular Hollow Structural Sections (HSS) shall be ASTM A500 Grade B steel. Pipe shall conform to ASTM A53 Grade B Pipe Specifications.
- B. Cast-in embedded anchor bolts and nuts shall be ASTM F1554, Grade 55 minimum, UNO, and shall be galvanized the full length. Nuts and washers shall be fully galvanized. Alternate anchor bolt material may be proposed for the Engineer's approval.
- C. Steel plate material shall be A36 steel as a minimum. See Detail Drawings for required plate material.
- D. Locknuts shall be M-F No. 1 (hex head).
- E. Locknuts and washers shall be galvanized to meet the requirements outlined below.
- F. Fabrication of structural steel shall be in accordance with the following requirements:
  - 1. Straightening material: Before being laid out or worked in any manner, structural material shall be straight and cleaned of all rust and dirt. If straightening is necessary, it shall be performed by methods that will not permanently deform the metal.
  - 2. Shearing and cutting: Shearing and cutting shall be performed carefully and all portions of the work which will be exposed to view after completion shall be finished neatly. Blades shall be sharp and clearances adjusted to provide smooth cuts. Manually guided cutting torches shall not be used.
  - 3. Holes: All holes in structural steel less than 13/16-inch thick may be punched to full size, unless otherwise noted on the Drawings. Holes shown on the Drawings as drilled holes and all holes in structural steel 13/16-inch or more in thickness shall be drilled or sub-punched and reamed. All holes shall be clean cut and without torn or ragged edges. All burrs resulting from reaming or drilling shall be removed with a tool that makes a 1/16-inch bevel. All holes shall be cylindrical and perpendicular to the member. Where necessary to avoid any distortion of the holes, holes close to the points of bends shall be made after bending.
  - 4. Punching: For punching to full size, the diameter of the punch shall be 1/16-inch larger than the diameter of the bolt. For sub-punching, the diameter of the punch shall be 3/16-inch smaller than the nominal diameter of the bolt, and the diameter of the die shall not be more than 3/32-inch larger than the diameter of the punch. Sub-punching for reamed work shall be such that after reaming no punched surface shall appear in the periphery of the hole.
  - 5. Reaming and drilling: Where holes are reamed or drilled, the diameter of the finished hole shall be no greater than the nominal diameter of the bolt plus 1/16-inch, unless otherwise noted on the Drawings.
  - 6. Accuracy of punching, reaming, and drilling: All holes shall be spaced accurately in accordance with the Drawings and be located on the gauge lines. The maximum allowable variation in hole spacing from that indicated on the Drawings for bolt holes shall be 1/32-inch.

7. Welding: All welding shall be performed in accordance with the latest edition of the "Structural Welding Code Steel," as formulated by the American Welding Society, and a shielded-arc-welding process shall be used. All welds shall be as shown on the Drawings and made in such a manner that residual shrinkage stresses will be reduced to a minimum. No stress-relieving treatment will be required. If not previously qualified, the welding process and the welding operators employed in performing the work covered by these Specifications shall be qualified in accordance with the American Welding Society Standard Qualification Procedure. Complete seal welding of all edges of contacting surfaces shall be required for the prevention of moisture collection and rusting.
8. If design of the structure employs hollow tubes or columns, all such tubes or columns shall be galvanized inside and outside and an approved plug provided for galvanizing holes that are exposed to the elements. Field drilling and tapping of such structures shall be held to a minimum and an approved sealer shall be applied to the threads of all bolts. The Fabricator shall be responsible for providing necessary vent holes as required for galvanizing. Vent hole design shall be such as to minimize the likelihood of bird or animal use after installation.

#### SFD.5 GALVANIZING

Cleaning and galvanizing of the structural steel shall be in accordance with the following:

- A. Cleaning: After the shop work has been completed and accepted, all materials shall be cleaned of rust, loose scale, dirt, oil, grease, and other foreign substances. Particular care shall be taken to clean slag from welded areas.
- B. Galvanizing of plates and shapes: All plates and shapes shall be galvanized after fabrication, except for members of assemblies built up by welding which may be galvanized before they are welded. All welds shall be coated and all galvanizing damaged by the welding operations shall be repaired as provided below. All materials after being cleaned, except as noted on the Drawings, shall be zinc coated (galvanized) in accordance with ASTM A123. Where members are of such lengths that they cannot be dipped in one (1) operation, great care shall be exercised to prevent warping. Finished compression members shall not have lateral variations greater than 1/1000 of the axial length between the points which are to be supported laterally. All holes in the material(s) shall be free of excess spelter after galvanizing.
- C. Galvanizing of hardware: Bolts, nuts, washers, locknuts, and similar hardware shall be galvanized in accordance with ASTM A153. Excess spelter shall be removed by centrifugal spinning.
- D. Straightening after galvanizing: All plates and shapes which have been warped by the galvanizing process shall be straightened by being re-rolled or pressed. These materials shall not be hammered or otherwise straightened in a manner that will injure the protective coating. If, in the opinion of the Inspector, any of the material has been harmfully bent or warped in the process of fabrication or galvanizing, such defects shall be cause for rejection.
- E. Repair of galvanizing: Any material on which galvanizing has been damaged shall be re-dipped unless, in the opinion of the Inspector, the damage is local and can be repaired by applying a coat of zinc dust-zinc oxide paint, galvo-weld, flame-weld, or other approved repair product. Where such repair is authorized, the damaged area shall be cleaned by wiping with clean rags that are saturated with mineral spirits or xylene, followed by hand wire brushing. After wire brushing, the area shall be re-cleaned with solvent to remove residue and repaired according to the Product Manufacturer's recommendations for providing a coating equal to or greater than 5.0 mil thickness. When used, zinc dust-zinc oxide paint shall be in accordance with ASTM A780: Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
- F. Any member shall be rejected on which the galvanized coating becomes damaged after having been dipped twice.

- G. The Fabricator shall demonstrate to the satisfaction of the Owner and Engineer that all galvanized structures are sufficiently protected for the Project's environmental conditions, as noted in Division GQ.

SFD.6 ASSEMBLY AND TRANSPORTATION

- A. Handling and transportation of structural steel shall be with care to avoid bending or damage to the galvanizing.
  - 1. Pieces bent in handling may only be used if they can be straightened without damage to the galvanizing coat.
  - 2. Any material on which the galvanizing has been damaged shall be re-dipped unless, in the opinion of the Engineer, the damage is local and can be repaired in the field in accordance with the provisions of these Specifications.
- B. Structures shall be assembled in the shop to such an extent as to ensure proper field erection.
- C. Steel shall be completely fabricated and shop assembled into the largest practical units. All pieces shall be marked to facilitate field erection.
- D. Structures shall be crated and packed for shipping so that no excessive stresses will be applied and to prevent damage to the surface finish.

**END OF DIVISION SFD**