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USACE / NAVFAC / AFCEC / NASA | UFGS-05 12 00 (August 2018)
Change 2 - 05/21

Preparing Activity: NAVFAC | Superseding
UFGS-05 12 00 (May 2014)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated July 2023
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SECTION 05 12 00

STRUCTURAL STEEL
08/18, CHG 2: 05/21

****
NOTE: This guide specification covers requirements for structural steel used in building construction. Review the following publications for material selection and additional specification requirements before using this guide specification for the following types of construction:

This specification does not cover Highway Bridges or Railroad bridges due to the fracture critical requirements for bridges. For bridge design considerations see AASHTO or AREMA.

Tower Construction - Telecommunications Industry Association (TIA), TIA-222-G-2, "Structural Standard for Antenna Supporting Structures and Antennas."

Adhere to UFC 1-300-02 Unified Facilities Guide Specifications (UFGS) Format Standard when editing this guide specification or preparing new project specification sections. Edit this guide specification for project specific requirements by adding, deleting, or revising text. For bracketed items, choose applicable item(s) or insert appropriate information.

Remove information and requirements not required in respective project, whether or not brackets are present.

Comments, suggestions and recommended changes for this guide specification are welcome and should be submitted as a Criteria Change Request (CCR).
****

****
NOTE: Ensure the following information is shown on the project drawings:

1. The extent and location of structural steel;

2. Designations of steel members;

3. Type and yield strength of steel used in design;

4. Locations where galvanized steel will be used;

5. Types of connections (welded and bolted);

6. Locations where high-strength bolts and slip critical connections are required and the loads and stresses required if steel connection design is provided by Contractor; and

7. The location of welds requiring nondestructive testing, along with the type of testing required.

8. Type of steel coating and limits of coating application; and

9. Type of coating for hardware.

****

PART 1 GENERAL

1.1 REFERENCES

****

NOTE: This paragraph is used to list the publications cited in the text of the guide specification. The publications are referred to in the text by basic designation only and listed in this paragraph by organization, designation, date, and title.

Use the Reference Wizard's Check Reference feature when you add a Reference Identifier (RID) outside of the Section's Reference Article to automatically place the reference in the Reference Article. Also use the Reference Wizard's Check Reference feature to update the issue dates.

References not used in the text will automatically be deleted from this section of the project specification when you choose to reconcile references in the publish print process.

****

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS (AASHTO)

AASHTO LRFD	(8th Edition; 2017) Bridge Design Specifications

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 207	(2016; R 2017) Certification Standard for Steel Fabrication and Erection, and Manufacturing of Metal Components
AISC 303	(2016) Code of Standard Practice for Steel Buildings and Bridges
AISC 325	(2017) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 341	(2016) Seismic Provisions for Structural Steel Buildings
AISC 360	(2016) Specification for Structural Steel Buildings
AISC 420	(2010) Certification Standard for Shop Application of Complex Protective Coating Systems
AISC DESIGN GUIDE 10	(1997) Erection Bracing of Low-Rise Structural Steel Buildings

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2020) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2020; Errata 1 2021) Structural Welding Code - Steel
AWS D1.8/D1.8M	(2016) Structural Welding Code—Seismic Supplement
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A6/A6M	(2022) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A29/A29M	(2020) Standard Specification for General Requirements for Steel Bars, Carbon and

	Alloy, Hot-Wrought
ASTM A36/A36M	(2019) Standard Specification for Carbon Structural Steel
ASTM A53/A53M	(2022) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A108	(2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143/A143M	(2007; R 2020) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A193/A193M	(2023) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A276/A276M	(2017) Standard Specification for Stainless Steel Bars and Shapes
ASTM A307	(2021) Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60 000 PSI Tensile Strength
ASTM A500/A500M	(2021a) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A563	(2021; E 2022a) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A668/A668M	(2023) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992/A992M	(2022) Standard Specification for Structural Steel Shapes
ASTM A1085/A1085M	(2015) Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)

ASTM B695	(2021) Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel
ASTM C827/C827M	(2016) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM C1107/C1107M	(2020) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM F436/F436M	(2019) Standard Specification for Hardened Steel Washers Inch and Metric Dimensions
ASTM F844	(2019) Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F959/F959M	(2017a) Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners, Inch and Metric Series
ASTM F1136/F1136M	(2011) Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners
ASTM F1554	(2020) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F2329/F2329M	(2015) Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
ASTM F2833	(2011; R 2017) Standard Specification for Corrosion Protective Fastener Coatings with Zinc Rich Base Coat and Aluminum Organic/Inorganic Type
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

CRANE MANUFACTURERS ASSOCIATION OF AMERICA (CMAA)

CMAA 70	(2020) Specification for Top Running Bridge and Gantry Type Multiple Girder Electric Overhead Traveling Cranes

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC Paint 20	(2019) Zinc-Rich Primers (Type I, Inorganic, and Type II, Organic)
SSPC Paint 29	(2002; E 2004) Zinc Dust Sacrificial Primer, Performance-Based
SSPC SP 3	(2018) Power Tool Cleaning
SSPC SP 6/NACE No.3	(2007) Commercial Blast Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01	(2023) Structural Engineering

U.S. NATIONAL ARCHIVES AND RECORDS ADMINISTRATION (NARA)

29 CFR Part 1926, Subpart R	Steel Erection

1.2 SUBMITTALS

****

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list, and corresponding submittal items in the text, to reflect only the submittals required for the project. The Guide Specification technical editors have classified those items that require Government approval, due to their complexity or criticality, with a "G." Generally, other submittal items can be reviewed by the Contractor's Quality Control System. Only add a "G" to an item if the submittal is sufficiently important or complex in context of the project.

For Army projects, fill in the empty brackets following the "G" classification, with a code of up to three characters to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy, Air Force, and NASA projects.

The "S" classification indicates submittals required as proof of compliance for sustainability Guiding Principles Validation or Third Party Certification and as described in Section 01 33 00 SUBMITTAL PROCEDURES.

Choose the first bracketed item for Navy, Air Force, and NASA projects, or choose the second bracketed

item for Army projects.
****

Government approval is required for submittals with a "G" or "S" classification. Submittals not having a "G" or "S" classification are [for Contractor Quality Control approval.][for information only. When used, a code following the "G" classification identifies the office that will review the submittal for the Government.] Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-01 Preconstruction Submittals

Erection and Erection Bracing Drawings; G[, [_____]]

SD-02 Shop Drawings

Fabrication Drawings Including Details of Connections; G[, [_____]]

SD-03 Product Data

Shop Primer

Welding Electrodes and Rods

Direct Tension Indicator Washers

Non-Shrink Grout

Tension Control Bolts

Recycled Content for Structural Steel; S

Recycled Content for Structural Steel Tubing; S

Recycled Content for Steel Pipe; S

SD-05 Design Data

[Design Calculations for Steel Connections; G[, [_____]]

][Shoring and Temporary Bracing; G[, [_____]]

] SD-06 Test Reports

Class B Coating

Bolts, Nuts, and Washers

Weld Inspection Reports

Direct Tension Indicator Washer Inspection Reports

Bolt Testing Reports

[Embrittlement Test Reports

] SD-07 Certificates

Steel

Bolts, Nuts, and Washers

[Galvanizing

][Pins and Rollers

][AISC Structural Steel Fabricator Quality Certification

][AISC Structural Steel Erector Quality Certification

] Welding Procedures and Qualifications

Welding Electrodes and Rods

Certified Welding Inspector

NDT Technician

Welding Procedure Specifications (WPS)

[Overhead, Top Running Crane Rail Beam

][1.3 AISC QUALITY CERTIFICATION

****
NOTE: AISC has a certification program in effect that confirms that a certified structural steel fabricating facility has the personnel, organization, experience, procedures, knowledge, equipment, capability, and commitment to produce fabricated steel of the required quality for a given category of structural steel framing. Consider deleting this paragraph if there is a minimal amount of steel on the job. MBMA has a certification program in effect that confirms that a certified metal building manufacturer's fabrication facility has the quality management system ensuring continual compliance with requirements for Metal Building Systems.
****

Work must be fabricated by an AISC Certified Structural Steel Fabricator, in accordance with AISC 207, Category BU. Submit AISC Structural Steel Fabricator quality certification.

Work must be erected by an AISC Structural Steel Certified Erector, in accordance with AISC 207, Category CSE. Submit AISC Structural Steel erector quality certification.

][1.4 SEISMIC PROVISIONS

****
NOTE: Delete this paragraph when the steel seismic force resisting system is classified as a steel system not specifically detailed for seismic resistance in accordance with ASCE 7-16, Table 12.2-1.
****

Provide the structural steel system in accordance with AISC 341, Chapter J as amended by UFC 3-301-01.

]1.5 QUALITY ASSURANCE

1.5.1 Preconstruction Submittals

1.5.1.1 Erection and Erection Bracing Drawings

****
NOTE: Include the last line when delegated design is performed by the contractor.
****

Submit for record purposes. Indicate the sequence of erection, temporary shoring and bracing. The erection drawings must conform to AISC 303.[Erection drawings must be reviewed, stamped and sealed by a registered professional engineer.]

1.5.2 Fabrication Drawing Requirements

****
NOTE: Include the requirement for fabrication drawings to be signed and sealed when delegated design is performed by the contractor.
****

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with AISC 303, AISC 326 and AISC 325. Fabrication drawings must not be reproductions of contract drawings.[Sign and seal fabrication drawings by a registered professional engineer.] Include complete information for the fabrication and erection of the structure's components, including the location, type, and size of bolts, welds, member sizes and lengths, connection details, blocks, copes, and cuts. Use AWS A2.4 standard welding symbols.[Shoring and temporary bracing must be designed and sealed by a registered professional engineer and submitted for record purposes[, with calculations,] as part of the drawings.] Clearly highlight any deviations from the details shown on the contract drawings highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

[1.5.3 Delegated Connection Design

****
NOTE: Include this paragraph when delegated design is performed by the contractor.

Provide connection loads on the drawings and indicate whether the loads are LRFD, ASD, or Combined.
****

Design structural steel connection indicated in the contract documents per AISC 303, Option 3, using the connection loads indicated. Submit design calculations for steel connections signed and sealed by a registered professional engineer.

]1.5.4 Certifications

1.5.4.1 Welding Procedures and Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests.[If the qualification date of the welder or welding operator is more than 6 months old, the welding operator's qualification certificate must be accompanied by a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.]

Conform to all requirements specified in AWS D1.1/D1.1M[and AWS D1.8/D1.8M].

****

NOTE: Include the following paragraph when there is a top running bridge crane in the project.

NAVINST 11230.1F refers to CMAA for new equipment installation.

****

[1.5.4.2 Overhead, Top Running Crane Rail Beam

Submit written field survey results for overhead, top running crane rail beam verifying tolerance requirements per CMAA 70.

]PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

****

NOTE: Check the design to ensure that adequate supports at appropriate spacings have been provided for the installation of piping, expansion tanks, unit heaters, suspended ceilings and similar items.

Consider provisions for using self-locking nuts where shock or vibration would be a problem.

****

Provide the structural steel system, including [shop primer] [galvanizing], complete and ready for use. Provide structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing in accordance with AISC 303, AISC 360, [AISC 341,]and UFC 3-301-01 except as modified in this contract.

2.2 STEEL

****

NOTE: Select materials appropriate to the design and delete remaining materials.

Designer should require materials, products, and innovative construction methods and techniques which are environmentally sensitive, take advantage of

recycling and conserve natural resources.
****

****
NOTE: Designs requiring notch strength or installation and operation at low temperatures will require special material selections. Notch strength will be required based on design geometry or for dynamically loaded structures. When notch toughness is required, the supplementary requirements of the ASTM specification for the steel being considered should be reviewed and the appropriate supplementary requirements (ASTM A6/A6M) specified. In designs where the material will be exposed to temperatures below freezing, check the material type against the proposed ambient and working temperatures for resistance to brittle fracture.
****

2.2.1 Structural Steel

****
NOTE: ASTM A992/A992M covers W shapes (rolled wide flange shapes) intended for use in building framing. Specify ASTM A36 for S, M, and HP shapes, channels, angles, and plates.

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets and delete the first set of brackets. AISC 2017 white paper "More than Recycled Content: The Sustainable Characteristics of Structural Steel" indicates that the industry average recycled content is 93 percent.
****

Wide flange and WT shapes, ASTM A992/A992M. Angles, Channels and Plates, ASTM A36/A36M. Provide structural steel containing a minimum of [80][_____] percent recycled content. Submit data identifying percentage of recycled content for structural steel.

2.2.2 Structural Steel Tubing

****
NOTE: ASTM A500/A500M tubing is available in Grades A, B, C, and D with minimum yield strengths of 230, 290, 317, and 250 MPa 33, 42, 46, and 36 ksi for round structural tubing and 269, 317, 345, and 250

MPa 39, 46, 50, and 36 ksi for square or rectangular shaped structural tubing, respectively. ASTM A500/A500M tubing may not be suitable for dynamically loaded structures or applications requiring notch strength.

ASTM A1085 provides tighter shape tolerance over ASTM A500 and minimum yield strength of 345 MPa 50 ksi and a maximum yield strength of 485 MPa 70 ksi for all round, square and rectangular shapes. ASTM A1085/A1085M also provides standard requirements for charpy V-notch toughness.

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets and delete the first set of bracket. AISC 2017 white paper "More than Recycled Content: The Sustainable Characteristics of Structural Steel" indicates that if the rolled coil used to form HSS shapes is from a basic oxygen furnace then the recycled content will be near 25 percent, but if the coil is from an electric arc furnace then the recycled content will be in 90 percent to 100 percent range.

****

ASTM A500/A500M, Grade [C][_____].[ASTM A1085/A1085M.] Provide structural steel tubing containing a minimum of [25][90][_____] percent recycled content. Submit data identifying percentage of recycled content for structural steel tubing.

2.2.3 Steel Pipe

****

NOTE: ASTM A53/A53M pipe, Type E (Electric-resistance Welded) and Type S (Seamless), Grade B, has a minimum yield strength of 245 MPa 35 ksi and is available in the following weight classes: STD (Standard), XS (Extra Strong), and XXS (Double-extra Strong).

Use materials with recycled content where appropriate for use. Verify suitability, availability within the region, cost effectiveness and adequate competition (including verification of bracketed percentages included in this guide specification) before specifying product recycled content requirements.

Where minimums are stated, research shows the product is available among US national manufacturers above the minimum recycled content of the first bracket. Some manufacturers and regions have higher percentages. If desired, insert higher percentages into the second set of brackets and delete the first set of brackets.
****

ASTM A53/A53M, Type E or S, Grade B, weight class [STD (Standard) or as indicated][_____]. Provide steel pipe containing a minimum of [50][_____] percent recycled content. Submit data identifying percentage of recycled content for steel pipe.

2.3 BOLTS, NUTS, AND WASHERS

Submit the certified manufacturer's mill reports which clearly show the applicable ASTM mechanical and chemical requirements together with the actual test results for the supplied fasteners.

2.3.1 Common Grade Bolts

2.3.1.1 Bolts

****
NOTE: When galvanizing ASTM A307 bolts specify either hot-dip process in ASTM F2329/F2329M or zinc-coated by the mechanical-deposition process in accordance with ASTM B695, Class 55.
****

ASTM A307, Grade A, plain finish [hot dipped zinc coating][mechanically deposited zinc coating]. The bolt heads and the nuts of the supplied fasteners must be marked with the manufacturer's identification mark, the strength grade and type specified by ASTM specifications.

2.3.1.2 Nuts

ASTM A563ASTM A563M, Grade A, heavy hex style.

[2.3.1.3 Self-Locking Nuts

****
NOTE: Drawings or specifications should identify where these items are used.
****

Provide nuts with a locking pin set in the nut. The locking pin must slide along the bolt threads, and by reversing the direction of the locking pin, the nut can be removed without damaging the nut or bolt. Provide stainless steel locking pins.

]2.3.1.4 Washers

ASTM F844.

2.3.2 High-Strength Bolts

High strength bolts and nuts must be shipped together in the same shipping container. Fasteners indicated to be galvanized shall be tested by the supplier to show that the galvanized nut with the supplied lubricant provided may be rotated from the snug tight condition well in excess of the rotation required for pretentioned installation without stripping. The supplier shall supply nuts that have been lubricated and tested with the supplied bolts.

2.3.2.1 Bolts

****
NOTE: Do not galvanize Grade F2280 bolts.
****

****
NOTE: Do not mix bolt Grade A325M A325 and Grade A490M A490 on the same diameter bolts in high strength connections. The Grade A325M A325 and Grade A490M A490 bolts specified are for a maximum diameter of M36 1.5 inch. If larger bolts are required, include the following ASTM publications in reference article:

ASTM A354 - Quenched and Tempered Alloy Steel Bolts, Studs, and Other Externally Threaded Fasteners

ASTM A449 - Quenched and Tempered Steel Bolts and Studs.

Type 1 bolts are carbon steel. Type 3 bolts are weathering steel.
****

ASTM F3125/F3125M, Grade A325M A325 [A490M A490], Type 1 [3] Heavy Hex Head Style, plain finish [hot dipped zinc coating][mechanically deposited zinc coating].

2.3.2.2 Nuts

ASTM A563M ASTM A563, Grade and Style as specified in the applicable ASTM bolt standard.

2.3.2.3 Direct Tension Indicator Washers

****
NOTE: If direct tension indicator washers are not used then tension control bolts are required per UFC 3-301-01. Use the Tension Control Bolts paragraph and delete the BOLTS, NUTS AND DIRECT TENSION INDICATOR WASHERS paragraph.

Include bracketed phrase if tension indicator washers are to be galvanized.
****

ASTM F959/F959M.[Provide ASTM B695, Class 55, Type 1 galvanizing.] Submit product data for direct tension indicator washers.

2.3.2.4 Washers

ASTM F436/F436M, plain carbon steel.

2.3.3 Tension Control Bolts

****
NOTE: Use Grade F1852 where high strength bolts (AISC Group A) with a minimum tension strength of 120 ksi are required. Use Grade F2280 where high strength bolts (AISC Group B) with a minimum tension strength of 150 ksi are required. Grade F2280 tension control bolts only have a plain assembly finish.
****

ASTM F3125/F3125M, Grade [F1852][F2280], Type 1, twistoff style assemblies consisting of steel structural bolts with splined ends, heavy-hex carbon steel nuts, and hardened carbon steel washers. Assembly finish must be [plain][mechanically deposited zinc coating]. Submit product data for tension control bolts.

2.3.4 Foundation Anchorage

****
NOTE: For most jobs, ASTM F1554 36 ksi anchor rods are used. If high tensile loads are anticipated, consider the use of 55 ksi or 105 ksi ASTM F1554 anchor rods. If stainless steel is considered, select from material in ASTM A193/A193M.
****

2.3.4.1 Anchor Rods

ASTM F1554 Gr 36 [55][105], Class 1A[2A].[Stainless steel ASTM A193/A193M.]

2.3.4.2 Anchor Nuts

ASTM A563 ASTM A563M, Grade A, hex style.[Stainless steel ASTM A193/A193M.]

2.3.4.3 Anchor Washers

ASTM F844.[Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M.]

2.3.4.4 Anchor Plate Washers

ASTM A36/A36M[Stainless steel [Type 304][Type 316] conforming to ASTM A276/A276M].

2.4 STRUCTURAL STEEL ACCESSORIES

2.4.1 Welding Electrodes and Rods

****
NOTE: Include AWS D1.8/D1.8M when required for seismic resisting systems.
****

AWS D1.1/D1.1M[and AWS D1.8/D1.8M]. Submit product data for welding electrodes and rods.

2.4.2 Non-Shrink Grout

****
NOTE: Some nonshrink grouts derive their nonshrink properties from an increase in volume of metal due to oxidation. Where oxidation is not desired for appearance sake, specify nonmetallic grout.
****

ASTM C1107/C1107M, with no ASTM C827/C827M shrinkage.[Grout must be nonmetallic.] Submit product data for non-shrink grout.

2.4.3 Welded Shear Stud Connectors

ASTM A29/A29M, Grades 1010 through 1020. AWS D1.1/D1.1M, Table 7.1, Type B.

[2.4.4 Pins and Rollers

ASTM A668/A668M, Class C, D, F, or G; ASTM A108, Grades 1016 to 1030. Provide as specified in AASHTO LRFD, Section 6.4.2, except provide pins in lengths to extend a minimum of 6 mm 0.25 inch beyond the outside faces of the connected parts.

][2.5 GALVANIZING

****
NOTE: Most structural steel is painted. If galvanized items are required, they must be indicated or specified. The galvanizing specified is by the hot-dip process. This process requires large amounts of energy and unevenly heats steel sections that are either large or thick, occasionally warping the steel sections. Using zinc coating by thermal spraying (metallizing) as an alternative to hot-dip galvanizing should be considered for certain steel sections. Consult the following American Welding Society (AWS) publications for further information:

TS-85 - Thermal Spraying - Practice, Theories, and Application

C2.2-67 - Recommended Practices for Metallizing with Aluminum and Zinc for Protection of Iron and Steel.
****

ASTM F2329/F2329M, ASTM F1136/F1136M, ASTM F2833 or ASTM B695 for threaded parts or ASTM A123/A123M for structural steel members, as applicable, unless specified otherwise galvanize after fabrication where practicable.

]2.6 FABRICATION

Fabrication must be in accordance with the applicable provisions of AISC 325. Fabrication and assembly must be done in the shop to the

greatest extent possible. Punch, subpunch and ream, or drill bolt [and pin] holes perpendicular to the surface of the member.

Compression joints depending on contact bearing must have a surface roughness not in excess of 13 micrometer 500 micro inch as determined by ASME B46.1, and ends must be square within the tolerances for milled ends specified in ASTM A6/A6M.

Shop splices of members between field splices will be permitted only where indicated on the Contract Drawings. Splices not indicated require the approval of the Contracting Officer.

****
NOTE: Include the following paragraph where there are truss chord splices on the project.
****

[Do not splice truss top and bottom chords except as approved by the Contracting Officer. Provide chord splices at panel joints at approximately the third point of the span. The center of gravity lines of truss members must intersect at panel points unless otherwise approved by the Contracting Officer. When the center of gravity lines do not intersect at a panel point, make provisions for the stresses due to eccentricity. Camber of trusses must be 3 mm 1/8 inch in 3.048 meters 10 feet unless otherwise indicated.

]2.6.1 Markings

Prior to erection, identify members by a painted erection mark. Connecting parts assembled in the shop for reaming holes in field connections must be match marked with scratch and notch marks. Do not locate erection markings on areas to be welded. Do not locate match markings in areas that will decrease member strength or cause stress concentrations.[Affix embossed tags to hot-dipped galvanized members.]

****
NOTE: SPE-P1 is for enclosed paint shop, SPE-P2 is for an outside but covered paint shop and SPE-P3 is for an outside paint shop. There are other paint shop qualification including NACE and SSPC which exceed AISC paint endorsements.
****

2.6.2 Shop Primer

****
NOTE: Generally, for interior use, standard structural steel with a minimum coating system of a shop primer is adequate. For exterior environments or areas open to the exterior, use coated galvanized steel or a zinc rich coating system described in UFC 3-190-06, Protective Coatings and Paints.
****

SSPC Paint 20 or SSPC Paint 29, (zinc rich primer). Shop prime structural steel, except as modified herein, in accordance with SSPC PA 1. Do not prime steel surfaces embedded in concrete, galvanized surfaces,[surfaces to receive sprayed-on fireproofing,][surfaces to receive epoxy coatings,][surfaces designed as part of a composite steel concrete

section,] or surfaces within 13 mm 0.5 inch of the toe of the welds prior to welding (except surfaces on which metal decking and shear studs are to be welded). If flash rusting occurs, re-clean the surface prior to application of primer. Apply primer [in accordance with endorsement "SPE-P1"["SPE-P2"]["SPE-P3"] of AISC 420 or approved equal NACE or SSPC certification] [_____]to a minimum dry film thickness of 0.05 mm 2.0 mil. Submit shop primer product data.

Prime slip critical surfaces with a Class B coating in accordance with AISC 325. Submit test report for Class B coating.

Prior to assembly, prime surfaces which will be concealed or inaccessible after assembly. Do not apply primer in foggy or rainy weather; when the ambient temperature is below 7 degrees C or over 35 degrees C 45 degrees F or over 95 degrees F; or when the primer may be exposed to temperatures below 4 degrees C 40 degrees F within 48 hours after application, unless approved otherwise by the Contracting Officer. Repair damaged primed surfaces with an additional coat of primer.

2.6.2.1 Cleaning

SSPC SP 6/NACE No.3, except steel exposed in spaces above ceilings, attic spaces, furred spaces, and chases that will be hidden to view in finished construction may be cleaned to SSPC SP 3 when recommended by the shop primer manufacturer. Maintain steel surfaces free from rust, dirt, oil, grease, and other contaminants through final assembly.

[2.6.3 [Fireproofing] [and] [Epoxy] Coated Surfaces

Clean and prepare surfaces to receive [sprayed-on fireproofing] [epoxy] coatings in accordance with the manufacturer's recommendations, and as specified in Section 07 81 00 SPRAY-APPLIED FIREPROOFING.

][2.6.4 Surface Finishes

****
NOTE: AISC states "finished" surfaces, where identified, should have a maximum roughness of 500. For pins and bearing surfaces, a maximum roughness of 125, in lieu of 500, is recommended.
****

ASME B46.1 maximum surface roughness of 125 for pin, pinholes, and sliding bearings, unless indicated otherwise.

]2.7 DRAINAGE HOLES

Drill adequate drainage holes to eliminate water traps. Hole diameter must be 13 mm 1/2 inch and location indicated on the detail drawings. Hole size and locations must not affect the structural integrity.

PART 3 EXECUTION

3.1 ERECTION

****
NOTE: For low-rise structural steel buildings, design the structure to be erected in accordance with AISC DESIGN GUIDE 10.

****

a. Erection of structural steel, except as indicated in item b. below, must be in accordance with the applicable provisions of AISC 325, AISC 303 and 29 CFR Part 1926, Subpart R.

b. For low-rise structural steel buildings (18 m 60 feet tall or less and a maximum of 2 stories), erect the structure in accordance with AISC DESIGN GUIDE 10.

After final positioning of steel members, provide full bearing under base plates and bearing plates using nonshrink grout. Place nonshrink grout in accordance with the manufacturer's instructions.

3.1.1 STORAGE

Store the material out of contact with the ground in such manner and location as to minimize deterioration.

3.2 CONNECTIONS

Except as modified in this section, design connections indicated in accordance with AISC 360. Build connections into existing work. Do not tighten anchor bolts set in concrete with impact torque wrenches. Holes must not be cut or enlarged by burning. Bolts, nuts, and washers must be clean of dirt and rust, and lubricated immediately prior to installation.

3.2.1 Common Grade Bolts

Tighten ASTM A307 bolts to a "snug tight" fit. "Snug tight" is the tightness that exists when plies in a joint are in firm contact. If firm contact of joint plies cannot be obtained with a few impacts of an impact wrench, or the full effort of a man using a spud wrench, contact the Contracting Officer for further instructions.

3.2.2 High-Strength Bolts

****

NOTE: If only tension control bolts are used, delete this paragraph.

****

Provide direct tension indicator washers in all ASTM F3125/F3125M, Grade A325M A325 and Grade A490M A490 bolted connections. Bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.

Fastener components shall be protected from dirt and moisture in closed containers at the site of the installation. Fastener components that are not incorporated into the work shall be returned to protected storage at the end of the work shift.

3.2.2.1 Installation of Direct Tension Indicator Washers (DTIW)

Where possible, install the DTIW under the bolt head and tighten the nut. If the DTIW is installed adjacent to the turned element, provide a flat washer between the DTIW and nut when the nut is turned for tightening, and between the DTIW and bolt head when the bolt head is turned for tightening. In addition to the LIW, provide flat washers under both the

bolt head and nut when ASTM F3125/F3125M, Grade A490M A490 bolts are used.

3.2.3 Tension Control Bolts

Bolts must be installed in connection holes and initially brought to a snug tight fit. After the initial tightening procedure, fully tension bolts, progressing from the most rigid part of a connection to the free edges.

3.3 GAS CUTTING

Use of gas-cutting torch in the field for correcting fabrication errors is not permitted on any major member in the structural framing. Use of a gas cutting torch will be permitted on minor members not under stress only after approval has been obtained from the Contracting Officer.

3.4 WELDING

****
NOTE: Include AWS D1.8/D1.8M when required for seismic resisting systems.
****

Welding must be in accordance with AWS D1.1/D1.1M[and AWS D1.8/D1.8M].[Grind exposed welds smooth as indicated.] Provide AWS D1.1/D1.1M qualified welders, welding operators, and tackers.

Develop and submit the Welding Procedure Specifications (WPS) for all welding, including welding done using prequalified procedures. Submit for approval all WPS, whether prequalified or qualified by testing.

3.4.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips

****
NOTE: Include last bracketed statement where required by prequalified connection requirements in AISC 358.
****

[Removal is not required][Remove only from finished areas].[Remove backing strips from bottom flange of moment connections, backgouge the root pass to sound weld metal and reinforce with a 8 mm 5/16 inch fillet weld minimum.]

3.5 SHOP PRIMER REPAIR

Repair shop primer in accordance with the paint manufacturer's recommendation for surfaces damaged by handling, transporting, cutting, welding, or bolting.

3.5.1 Field Priming

Field prime steel exposed to the weather, or located in building areas without HVAC for control of relative humidity. After erection, the field bolt heads and nuts, field welds, and any abrasions in the shop coat must be cleaned and primed with paint of the same quality as that used for the shop coat.

[3.6 GALVANIZING REPAIR

Repair damage to galvanized coatings using ASTM A780/A780M zinc rich paint for galvanizing damaged by handling, transporting, cutting, welding, or bolting. Do not heat surfaces to which repair paint has been applied.

]3.7 FIELD QUALITY CONTROL

Perform field tests, and provide labor, equipment, and incidentals required for testing[, except that electric power for field tests will be furnished as set forth in Division 1]. Notify the Contracting Officer in writing of defective welds, bolts, nuts, and washers within 7 working days of the date of the inspection.

3.7.1 Welds

3.7.1.1 Visual Inspection

AWS D1.1/D1.1M. Furnish the services of AWS-certified welding inspectors for fabrication and erection inspection and testing and verification inspections. A Certified Welding Inspector must perform visual inspection on 100 percent of all welds. Document this inspection in the Visual Weld Inspection Log. Submit certificates indicating that certified welding inspectors meet the requirements of AWS QC1.

[Inspect proper preparation, size, gaging location, and acceptability of all welds; identification marking; operation and current characteristics of welding sets in use.

]3.7.1.2 Nondestructive Testing

****

NOTE: Indicate the location of test welds and types of testing desired. The following information is presented as guidance. Dye penetrant testing detects small surface defects by enhancing the visibility of the flaw. Magnetic particle testing detects surface cracks and near-surface cracks; this test provides more information than the dye penetrant testing, and for approximately the same cost. Ultrasonic testing detect surface and internal cracks, delaminations, lack of fusion, and density and thickness variations. Generally, fillet welds can only be dye penetrant or magnetic particle tested. All complete penetration welds should be ultrasonically tested. See AWS D1.1/D1.1M for other methods of NDT that can be used for testing welds.

Include AWS D1.8/D1.8M when required for seismic resisting systems.

AWS D1.1 does not require any NDT other than visual inspection unless specified by the Engineer. AWS D1.8 specifically required NDT for seismic connections. The engineer must specify which welds require inspection.

For statically loaded welds test per Table 6.2 of AWS D1.1. For cyclically loaded welds test per

Table 6.3 of AWS D1.1. Where welds are subjected to cyclic loading identify them on the construction documents.
****

Nondestructive testing must be in accordance with AWS D1.1/D1.1M[and AWS D1.8/D1.8M]. Ultrasonic testing must be performed in accordance with Table [6.2] [or 6.3] of AWS D1.1/D1.1M. Test locations must be [as indicated][selected by the Contracting Officer]. All personnel performing NDT must be certified in accordance with ANSI/ASNT CP-189 in the method of testing being performed. Submit certificates showing compliance with ANSI/ASNT CP-189 for all NDT technicians. If more than [20] [_____] percent of welds made by a welder contain defects identified by testing, then all groove welds made by that welder must be tested by ultrasonic testing, and all fillet welds made by that welder must be inspected by magnetic particle testing (MT) or dye penetrant testing (PT) as approved by the Contracting Officer. When groove welds made by an individual welder are required to be tested, magnetic particle or dye penetrant testing may be used only in areas inaccessible to ultrasonic testing. Retest all repaired areas. Submit weld inspection reports.

Testing frequency: Provide the following types and number of tests:

Test Type	Number of Tests
Ultrasonic	[_____]50 percent of CJP Welds
Magnetic Particle	[_____]50 percent of PJP and Fillet Welds
Dye Penetrant	[_____]50 percent of PJP and Fillet Welds
[_____]	[_____]

****
NOTE: If only tension control bolts are used, delete this paragraph.
****

3.7.2 Direct Tension Indicator Washers

3.7.2.1 Direct Tension Indicator Washer Compression

Test direct tension indicator washers in place to verify that they have been compressed sufficiently to provide the 0.38 mm 0.015 inch gap, as required by ASTM F959/F959M. Submit direct tension indicator washer inspection reports.

[3.7.2.2 Direct Tension Indicator Gaps

****
NOTE: Use this paragraph on large complex structural steel systems or on jobs where minimal on site inspection is expected.
****

In addition to the above testing, an independent testing agency as approved by the Contracting Officer, must test in place the direct tension

indicator gaps on 20 percent of the installed direct tension indicator washers to verify that the ASTM F959/F959M direct tension indicator gaps have been achieved. If more than 10 percent of the direct tension indicators tested have not been compressed sufficiently to provide the average gaps required by ASTM F959/F959M, test all in place direct tension indicator washers to verify that the ASTM F959/F959M direct tension indicator gaps have been achieved. Test locations must be selected by the Contracting Officer.

]3.7.3 High-Strength Bolts

3.7.3.1 Testing Bolt, Nut, and Washer Assemblies

Test a minimum of [3] [_____] bolt, nut, and washer assemblies from each mill certificate batch in a tension measuring device at the job site prior to the beginning of bolting start-up. Demonstrate that the bolts and nuts, when used together, can develop tension not less than the provisions specified in AISC 360, depending on bolt size and grade. The bolt tension must be developed by tightening the nut. A representative of the manufacturer or supplier must be present to ensure that the fasteners are properly used, and to demonstrate that the fastener assemblies supplied satisfy the specified requirements. Submit bolt testing reports.

3.7.3.2 Inspection

Inspection procedures must be in accordance with AISC 360. Confirm and report to the Contracting Officer that the materials meet the project specification and that they are properly stored. Confirm that the faying surfaces have been properly prepared before the connections are assembled. Observe the specified job site testing and calibration, and confirm that the procedure to be used provides the required tension. Monitor the work to ensure the testing procedures are routinely followed on joints that are specified to be fully tensioned.

[Inspect calibration of torque wrenches for high-strength bolts.

]3.7.3.3 Testing

The Government has the option to perform nondestructive tests on [5] [_____] percent of the installed bolts to verify compliance with pre-load bolt tension requirements. Provide the required access for the Government to perform the tests. The nondestructive testing will be done in-place using an ultrasonic measuring device or any other device capable of determining in-place pre-load bolt tension. The test locations must be selected by the Contracting Officer. If more than [10] [_____] percent of the bolts tested contain defects identified by testing, then all bolts used from the batch from which the tested bolts were taken, must be tested at the Contractor's expense. Retest new bolts after installation at the Contractor's expense.

[3.7.4 Testing for Embrittlement

ASTM A143/A143M for steel products hot-dip galvanized after fabrication. Submit embrittlement test reports.

]3.7.5 Inspection and Testing of Steel Stud Welding

Perform verification inspection and testing of steel stud welding conforming to the requirements of AWS D1.1/D1.1M, Stud Welding Clause.

The Contracting Officer will serve as the verification inspector. Bend test studs that do not show a full 360 degree weld flash or have been repaired by welding as required by AWS D1.1/D1.1M, Stud Welding Clause. Studs that crack under testing in the weld, base metal or shank will be rejected and replaced by the Contractor at no additional cost.

-- End of Section --