
USACE / NAVFAC / AFCEC / NASA UFGS-05 12 00 (May 2014)
Change 1 - 11/14

Preparing Activity: NAVFAC Superseding
UFGS-05 12 00 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2017

SECTION TABLE OF CONTENTS

DIVISION 05 - METALS

SECTION 05 12 00

STRUCTURAL STEEL

05/14

PART 1 GENERAL

- 1.1 REFERENCES
- 1.2 SUBMITTALS
- 1.3 AISC QUALITY CERTIFICATION
- 1.4 SEISMIC PROVISIONS
- 1.5 QUALITY ASSURANCE
 - 1.5.1 Preconstruction Submittals
 - 1.5.1.1 Erection Drawings
 - 1.5.2 Fabrication Drawing Requirements
 - 1.5.3 Certifications
 - 1.5.3.1 Welding Procedures and Qualifications

PART 2 PRODUCTS

- 2.1 SYSTEM DESCRIPTION
- 2.2 STEEL
 - 2.2.1 Structural Steel
 - 2.2.2 Structural Steel Tubing
 - 2.2.3 Steel Pipe
- 2.3 BOLTS, NUTS, AND WASHERS
 - 2.3.1 Common Grade Bolts
 - 2.3.1.1 Bolts
 - 2.3.1.2 Nuts
 - 2.3.1.3 Self-Locking Nuts
 - 2.3.1.4 Washers
 - 2.3.2 High-Strength Bolts
 - 2.3.2.1 Bolts
 - 2.3.2.2 Nuts
 - 2.3.2.3 Direct Tension Indicator Washers
 - 2.3.2.4 Washers
 - 2.3.3 Tension Control Bolts
 - 2.3.4 Foundation Anchorage
 - 2.3.4.1 Anchor Rods
 - 2.3.4.2 Anchor Nuts

- 2.3.4.3 Anchor Washers
- 2.3.4.4 Anchor Plate Washers
- 2.4 STRUCTURAL STEEL ACCESSORIES
 - 2.4.1 Welding Electrodes and Rods
 - 2.4.2 Non-Shrink Grout
 - 2.4.3 Welded Shear Stud Connectors
 - 2.4.4 Pins and Rollers
- 2.5 GALVANIZING
- 2.6 FABRICATION
 - 2.6.1 Markings
 - 2.6.2 Shop Primer
 - 2.6.2.1 Cleaning
 - 2.6.3 [Fireproofing] [and] [Epoxy] Coated Surfaces
 - 2.6.4 Surface Finishes
- 2.7 DRAINAGE HOLES

PART 3 EXECUTION

- 3.1 ERECTION
 - 3.1.1 STORAGE
- 3.2 CONNECTIONS
 - 3.2.1 Common Grade Bolts
 - 3.2.2 High-Strength Bolts
 - 3.2.2.1 Installation of Direct Tension Indicator Washers (DTIW)
 - 3.2.3 Tension Control Bolts
- 3.3 GAS CUTTING
- 3.4 WELDING
 - 3.4.1 Removal of Temporary Welds, Run-Off Plates, and Backing Strips
- 3.5 SHOP PRIMER REPAIR
 - 3.5.1 Field Priming
- 3.6 GALVANIZING REPAIR
- 3.7 FIELD QUALITY CONTROL
 - 3.7.1 Welds
 - 3.7.1.1 Visual Inspection
 - 3.7.1.2 Nondestructive Testing
 - 3.7.2 Direct Tension Indicator Washers
 - 3.7.2.1 Direct Tension Indicator Washer Compression
 - 3.7.2.2 Direct Tension Indicator Gaps
 - 3.7.3 High-Strength Bolts
 - 3.7.3.1 Testing Bolt, Nut, and Washer Assemblies
 - 3.7.3.2 Inspection
 - 3.7.3.3 Testing
 - 3.7.4 Testing for Embrittlement

-- End of Section Table of Contents --

USACE / NAVFAC / AFCEC / NASA UFGS-05 12 00 (May 2014)
Change 1 - 11/14

Preparing Activity: NAVFAC Superseding
UFGS-05 12 00 (November 2011)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated April 2017

SECTION 05 12 00

STRUCTURAL STEEL
05/14

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

Highway Bridges - American Association of State Highway and Transportation Officials (AASHTO)

Railroad Bridges - American Railway Engineering & Maintenance-of-Way Association (AREMA)

Tower Construction - Telecommunications Industry Association (TIA), RS-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: The following information must be shown on the project drawings:

1. The extent and location of structural steel;

2. Designations of steel members;
3. 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 design is provided by Contractor; and
7. The location of welds requiring nondestructive testing, along with the type of testing required.

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 HB-17 (2002; Errata 2003; Errata 2005, 17th Edition) Standard Specifications for Highway Bridges

AMERICAN INSTITUTE OF STEEL CONSTRUCTION (AISC)

AISC 201 (2006) AISC Certification Program for Structural Steel Fabricators

AISC 303	(2016) Code of Standard Practice for Steel Buildings and Bridges
AISC 325	(2011) Steel Construction Manual
AISC 326	(2009) Detailing for Steel Construction
AISC 341	(2012) Seismic Provisions for Structural Steel Buildings
AISC 360	(2010) Specification for Structural Steel Buildings
AISC DESIGN GUIDE 10	(1997) Erection Bracing of Low-Rise Structural Steel Buildings

AMERICAN WELDING SOCIETY (AWS)

AWS A2.4	(2012) Standard Symbols for Welding, Brazing and Nondestructive Examination
AWS D1.1/D1.1M	(2015; Errata 1 2015; Errata 2 2016) Structural Welding Code - Steel
AWS D1.8/D1.8M	(2009) Structural Welding Code—Seismic Supplement

ASME INTERNATIONAL (ASME)

ASME B46.1	(2009) Surface Texture, Surface Roughness, Waviness and Lay
------------	---

ASTM INTERNATIONAL (ASTM)

ASTM A108	(2013) Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished
ASTM A1085	(2013) Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)
ASTM A123/A123M	(2015) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A143/A143M	(2007; R 2014) Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement
ASTM A193/A193M	(2016) Standard Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service and Other Special Purpose Applications
ASTM A276/A276M	(2016a) Standard Specification for Stainless Steel Bars and Shapes

ASTM A29/A29M	(2016) Standard Specification for General Requirements for Steel Bars, Carbon and Alloy, Hot-Wrought
ASTM A307	(2014) Standard Specification for Carbon Steel Bolts and Studs, 60 000 PSI Tensile Strength
ASTM A325	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM A325M	(2014) Standard Specification for Structural Bolts, Steel, Heat Treated, 830 MPa Minimum Tensile Strength (Metric)
ASTM A36/A36M	(2014) Standard Specification for Carbon Structural Steel
ASTM A490	(2014a) Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM A490M	(2014a) Standard Specification for High-Strength Steel Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric)
ASTM A500/A500M	(2013) Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes
ASTM A53/A53M	(2012) Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
ASTM A563	(2015) Standard Specification for Carbon and Alloy Steel Nuts
ASTM A563M	(2007; R 2013) Standard Specification for Carbon and Alloy Steel Nuts (Metric)
ASTM A6/A6M	(2016a) Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
ASTM A668/A668M	(2016) Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use
ASTM A780/A780M	(2009; R 2015) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM A992/A992M	(2011) Standard Specification for Structural Steel Shapes
ASTM B695	(2004; R 2016) Standard Specification for

Coatings of Zinc Mechanically Deposited on
Iron and Steel

ASTM C1107/C1107M	(2014a) Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink)
ASTM C827/C827M	(2016) Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures
ASTM F1554	(2015; E 2016) Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength
ASTM F1852	(2014) Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ASTM F2280	(2014) Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM F2329	(2013) Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
ASTM F436	(2011) Hardened Steel Washers
ASTM F436M	(2011) Hardened Steel Washers (Metric)
ASTM F844	(2007a; R 2013) Washers, Steel, Plain (Flat), Unhardened for General Use
ASTM F959	(2013) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners
ASTM F959M	(2013) Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners (Metric)

SOCIETY FOR PROTECTIVE COATINGS (SSPC)

SSPC PA 1	(2016) Shop, Field, and Maintenance Coating of Metals
SSPC Paint 20	(2002; E 2004) 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	(1982; E 2004) Power Tool Cleaning

U.S. DEPARTMENT OF DEFENSE (DOD)

UFC 3-301-01

(2013; with Change 1) Structural
Engineering

UFC 3-310-04

(2013) Seismic Design for Buildings

1.2 SUBMITTALS

NOTE: Review Submittal Description (SD) definitions in Section 01 33 00 SUBMITTAL PROCEDURES and edit the following list to reflect only the submittals required for the project.

The Guide Specification technical editors have designated 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 submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation 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.

Use the "S" classification only in SD-11 Closeout Submittals. The "S" following a submittal item indicates that the submittal is required for the Sustainability eNotebook to fulfill federally mandated sustainable requirements in accordance with Section 01 33 29 SUSTAINABILITY REPORTING.

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" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] Submittals with an "S" are for inclusion in the Sustainability eNotebook, in conformance to Section 01 33 29 SUSTAINABILITY REPORTING. Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:


```

SD-01 Preconstruction Submittals
[      Erection Drawings; G[, [____]]
]
SD-02 Shop Drawings
[      Fabrication Drawings Including Description of Connections; G[,
[____]]
]
SD-03 Product Data
      Shop Primer
      Welding Electrodes and Rods
      Direct Tension Indicator Washers
      Non-Shrink Grout
[      Tension Control Bolts
]
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 Fabrication Plant Quality Certification
][      AISC Erector Quality Certification
]
      Welding Procedures and Qualifications
[      Welding Electrodes and Rods
][1.3  AISC QUALITY CERTIFICATION

```

**NOTE: AISC has a certification program in effect
that confirms that a certified structural steel**

fabricating plant 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. Use Category "Std" for both Complex and Conventional Steel Structures (replaces Sbd and Cbd categories); use Category "Sbr" for Simple Steel Bridge Structures; ; use Category "Cbr" for Major Steel Bridges MBMA has a certification program in effect that confirms that a certified metal building manufacturer's fabrication plant has the quality management system ensuring continual compliance with requirements for Metal Building Systems.

Specify Certified Steel Erectors [CSE] for most projects including: low-rise beam and column structures, light structural steel truss structures, and steel frame buildings up to 10 stories in height. Advances Certified Steel Erector [ACSE] is specified where the project requires retrofits, maintenance, or large scale erection projects using jacking or falsework.

Work must be fabricated in an AISC Certified Fabrication Plant, Category [Std] [_____]. Submit AISC fabrication plant quality certification.

Work must be erected by an AISC Certified Erector, Category [ASCE][CSE]. Submit AISC erector quality certification.

]1.4 SEISMIC PROVISIONS

The structural steel system must be provided in accordance with AISC 341, Chapter J as amended by UFC 3-310-04.

]1.5 QUALITY ASSURANCE

1.5.1 Preconstruction Submittals

1.5.1.1 Erection Drawings

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

Submit fabrication drawings for approval prior to fabrication. Prepare in accordance with 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.] Any deviations from the details shown on the contract drawings must be clearly highlighted on the fabrication drawings. Explain the reasons for any deviations from the contract drawings.

1.5.3 Certifications

1.5.3.1 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 welding operator is more than one-year 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].

PART 2 PRODUCTS

2.1 SYSTEM DESCRIPTION

NOTE: The design should be checked 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.

Provisions for using self-locking nuts should be considered where shock or vibration would be a problem.

Provide the structural steel system, including [shop primer] [galvanizing], complete and ready for use. Structural steel systems including design, materials, installation, workmanship, fabrication, assembly, erection, inspection, quality control, and testing must be provided in accordance with AISC 360, AISC 341, UFC 3-301-01 and UFC 3-310-04 except as modified in this contract.

2.2 STEEL

NOTE: Materials appropriate to the design will be selected and remaining materials will be deleted.

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, the material type should be checked 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. For S, M, and HP shapes, channels, angles, and plates A36 should be specified.

Wide flange and WT shapes, ASTM A992/A992M. Angles, Channels and Plates, ASTM A36/A36M.

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 288, 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 shaped structural tubing, respectively. ASTM A500/A500M tubing may not be suitable for dynamically loaded structures or applications requiring notch strength. For steel tubing, normally only ASTM A500/A500M, Grade B is stocked.

ASTM A1085 provides tighter shape tolerance over ASTM A500 and uniform yield strength of 345 MPa 50 ksi for all round, square and rectangular shapes.

ASTM A500/A500M, Grade [C] [_____]. [ASTM A1085]

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).

ASTM A53/A53M, Type E or S, Grade B, weight class [STD (Standard)] [_____].

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 or zinc-coated
by the mechanical-deposition process in accordance
with ASTM B695, Class 55.

ASTM A307, Grade A. 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 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 must 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

2.3.2.1 Bolts

NOTE: Do not galvanize ASTM A490M ASTM A490 bolts.
When galvanizing ASTM A325M ASTM A325 bolts limit
hardness of bolts to Rockwell C-32.

NOTE: Do not mix bolt material specifications ASTM
A325M and ASTM A490M ASTM A325 and ASTM A490 on the
same diameter bolts in high strength connections.
Do not place ASTM A325M and ASTM A490M ASTM A325 and
ASTM A490 bolts, which have a hardness equal or in
excess of Rockwell C-32, in contact with a
galvanized surface. The ASTM A325M and ASTM A490M

ASTM A325 and ASTM 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.

ASTM A325M ASTM A325, Type 1 ASTM A490M ASTM A490, Type 1 or 2.

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 F959M ASTM F959.[Provide ASTM B695, Class 50, Type 1 galvanizing.]

2.3.2.4 Washers

ASTM F436M ASTM F436, plain carbon steel.

2.3.3 Tension Control Bolts

NOTE: Use ASTM F1852 where high strength bolts (AISC Group A) with a minimum tension strength of 120/105 ksi are required. Use ASTM F2280 where high strength bolts (AISC Group B) with a minimum tension strength of 150 ksi are required. ASTM F2280 tension control bolts only have a plain assembly finish.

ASTM F1852[ASTM F2280], Type 1, [heavy-hex][round] head 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].

2.3.4 Foundation Anchorage

NOTE: For most jobs, ASTM F1554 36 ksi anchor rods

are used. If high tensile loads are anticipated, the designer should consider the use of 55 ksi or 105 ksi ASTM F1554 anchor rods. If stainless steel is considered, the designer should 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 A563, 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].

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.]

2.4.3 Welded Shear Stud Connectors

ASTM A29/A29M, Type B. AWS D1.1/D1.1M.

[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 HB-17, Division II, Sections 10.26 and 10.27, 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. The following American Welding Society (AWS) publications should be consulted 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 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. Chord splices must occur 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, provisions must be made 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.

12.6.1 Markings

Prior to erection, members must be identified 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.]

2.6.2 Shop Primer

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 is to be welded). If flash rusting occurs, re-clean the surface prior to application of primer. Apply primer [in accordance with endorsement "P1"["P2"]["P3"] of AISC 201] [_____] to a minimum dry film thickness of 0.05 mm 2.0 mil.

Slip critical surfaces must be primed 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.

12.6.3 [Fireproofing] [and] [Epoxy] Coated Surfaces

Surfaces to receive [sprayed-on fireproofing] [epoxy] coatings must be cleaned and prepared in accordance with the manufacturer's recommendations, and as specified in Section 07 81 00 SPRAY-APPLIED FIREPROOFING.

12.6.4 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.

12.7 DRAINAGE HOLES

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

PART 3 EXECUTION

3.1 ERECTION

NOTE: For low-rise structural steel buildings, the designer must 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.
- b. For low-rise structural steel buildings (18 m 60 feet tall or less and a maximum of 2 stories), the structure must be erected 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

Material must be stored out of contact with the ground in such manner and location as will minimize deterioration.

3.2 CONNECTIONS

Except as modified in this section, connections not detailed must be designed 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

ASTM A307 bolts must be tightened 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: The four bolt tightening methods currently allowed by AISC will provide acceptable results if bolt assemblies are kept free of dirt and rust, if properly lubricated, and if proper installation procedures are followed. Because these conditions

**are rarely encountered during normal construction,
use only direct tension indicator tightening methods.**

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

3.2.2.1 Installation of Direct Tension Indicator Washers (DTIW)

Where possible, the DTIW must be installed under the bolt head and the nut must be tightened. 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 DTIW, provide flat washers under both the bolt head and nut when ASTM A490M ASTM 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, bolts must then be fully tensioned, 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 will not be 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. Prequalified procedures may be submitted for information only; however, procedures that are not prequalified must be submitted for approval.

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

[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

Steel exposed to the weather, or located in building areas without HVAC for control of relative humidity must be field primed. 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]. The Contracting Officer must be notified 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.

[Inspection by the Government will include proper preparation, size, gaging location, and acceptability of welds; identification marking; operation and current characteristics of welding sets in use.

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

]3.7.1.2 Nondestructive Testing

NOTE: The designer must 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.

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

Nondestructive testing must be in accordance with AWS D1.1/D1.1M[and AWS D1.8/D1.8M]. Test locations must be [as indicated] [selected by the Contracting Officer]. If more than [20] [_____] percent of welds made by a welder contain defects identified by testing, then all welds made by that welder must be tested by ultrasonic testing, as approved by the Contracting Officer. When all welds made by an individual welder are required to be tested, magnetic particle testing must be used only in areas inaccessible to ultrasonic testing. Retest defective areas after repair. Submit weld inspection reports.

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

Test Type	Number of Tests
Ultrasonic	[_____]
Magnetic Particle	[_____]
Dye Penetrant	[_____]

3.7.2 Direct Tension Indicator Washers

3.7.2.1 Direct Tension Indicator Washer Compression

Direct tension indicator washers must be tested in place to verify that they have been compressed sufficiently to provide the 0.38 mm 0.015 inch gap when the direct tension indicator washer is placed under the bolt head and the nut is tightened, and to provide the 0.13 mm 0.005 inch gap when the direct tension indicator washer is placed under the turned element, as required by ASTM F959M ASTM F959. 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 F959M ASTM F959 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 F959M ASTM F959, then all in place direct tension indicator washers shall be tested to verify that the ASTM F959M ASTM F959 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.

[Inspection by the Government will include calibration of torque wrenches for high-strength bolts.

] [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.

] -- End of Section --