SUMMARY OF MAJOR CHANGES APPEARING IN PUBLIC REVIEW ONE DRAFT OF AISC 303-27

The following is a list of major changes appearing in the public review draft of AISC 303-27 dated April 21, 2025.

- Glossary: The definition of the term “adjustable items” was updated in coordination with changes in Section 11. Definitions for the terms “benchmark” and “control lines” were added as part of these Section 11 changes. A definition for the term “architecturally exposed structural steel” was written in lieu of relying on Code requirements in Section 10 to serve as the definition.
- Section 1.8: This section on patents and copyrights has been rewritten to clarify its intent.
- Section 1.12: Commentary has been added to this section on protected zones in seismic force-resisting systems.
- Section 1.13: This is a new section that was added to address responsibilities on projects that have sustainability requirements.
- Section 3.2.3: Requirements have been added for what to include in structural design documents and specifications concerning adjustable items and embedded items.
- Section 4.2.1: Requirements have been added regarding what to include in approval documents.
- Section 4.3: This section was edited to clarify the language with respect to digital models.
- Section 4.5: This section has been updated to remove vague language.
- Section 7.4: This section has been updated to incorporate new terminology for control lines and benchmarks.
- Section 7.5: This section has been updated to clarify the treatment of adjustable items and embedded items.
- Section 7.6.4: Commentary discussion has been introduced about pre-grouted leveling plates.
- Section 8.5.2: The section has been updated to remove vague language.
- Section 9.5.1: This section on scheduling has been rewritten to clarify its intent.
- Section 10.4.2: The exception pertaining to fabrication and erection marks on unfinished steel has been clarified.
- Section 10.4.3: The scope of this section has been expanded to tolerances that appear in any applicable ASTM standard.
- Table 10.1: The requirement for filling open holes for AESS 4, which already existed in the text of the Code, has been added to this table.
- Figures C-11.3 and C-11.5: Terminology has been clarified in the annotation of Figure C-11.3 and the caption in Figure C-11.5 about vertical adjustment has been deleted.
- Section 11.3.1.3: The requirements for tolerances of adjustable items have been updated and clarified.
- Section 11: Language conventions have been updated for consistency and clarity.

AISC 303-xx

Code of Standard Practice for Steel Buildings and Bridges

DRAFT Dated April 21, 2025

(Not yet) Approved by the Committee
on the Code of Standard Practice

AMERICAN INSTITUTE OF STEEL CONSTRUCTION
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GLOSSARY

The following terms are used in this Code. Where used, terms are italicized to alert the user that the term is defined in this Glossary.

Adjustable items. Pieces that attach to the structural steel frame, such as façade support systems, bent plate pour stops, and elevator rail supports, which are made to be adjustable in the field by the use of connecting features such as oversized holes, slotted holes, field welding, or field drilling.

Allowance. A monetary amount included in a contract as a placeholder for work that is anticipated but not defined at the time the contract is executed.

Anchor bolt. See *Anchor rod*.

Anchor rod. A mechanical device that is either cast or drilled and chemically adhered, grouted, or wedged into concrete or masonry for the purpose of the subsequent attachment of *structural steel*.

Applicable building code. Building code under which the structure is designed.

Approval documents. The *structural steel shop drawings*, *erection drawings*, and *embedment drawings*, or where the parties have agreed in the *contract documents* to provide digital model(s), the *fabrication* and *erection models*. A combination of drawings and digital models also may be provided.

Architecturally exposed structural steel (AESS). *Structural steel* elements which will be exposed to view in the final construction and are specified in the *contract documents* to comply with the requirements of Section 10.

Bearing devices. Shop-attached base and bearing plates, loose base and bearing plates, and leveling devices, such as leveling plates, leveling nuts and washers, and leveling screws.

Benchmarks: Reference points for facilitating the vertical positioning and aligning the steel frame.

Building column line. The grid line of column centers set in the field based on the dimensions shown on the structural *design documents* and using the building layout provided by the *owner's designated representative for construction*. Column offsets are taken from the *building column line*. The *building column line* may be straight or curved as shown in the structural *design documents*.

Camber. Either continuous or segmented curvature in a beam or truss to compensate for deflection induced by loads.

Clarification. An interpretation, of the *design drawings* or *specifications* that have been *released for construction*, made in response to an *RFI* or a note on an approval drawing and providing an explanation that neither revises the information that has been *released for construction* nor alters the cost or schedule of performance of the work.

The Code, This Code. This document, the AISC *Code of Standard Practice for Steel Buildings and Bridges* as adopted by the American Institute of Steel Construction.

Connection. An assembly of one or more joints that is used to transmit forces between two or more members.

Construction documents. Written, graphic, and pictorial documents prepared or assembled for describing the design (including the structural system), location, and physical characteristics of the elements of a building necessary to obtain a building permit and construct a building.

Contract documents. The documents that define the responsibilities of the parties that are involved in bidding, fabricating, and erecting *structural steel*. *Contract documents* include the *design documents*, the *specifications,* and the contract.

Control Lines. Reference lines for facilitating the horizontal positioning and aligning the steel frame. Control lines are normally offset from the building column lines.

Design documents. *Design drawings*, *design model*, or a combination of drawings and models.

Design drawings. Graphic and pictorial portions of the *contract documents* showing the design, location, and dimensions of the work. These documents generally include, but are not necessarily limited to, *plans*, elevations, sections, details, schedules, diagrams, and notes.

Design model. Three-dimensional digital model of the structure that conveys the *structural steel* requirements given in Section 3.1.

Embedment drawings. Drawings that show the location and placement of items that are installed to receive *structural steel*.

Engineer of record. See *Structural engineer of record*.

Erection documents. Erection drawings, *erection model*, or a combination of drawings and models.

Erection drawings. Field-installation or member-placement drawings showing the location and attachment of the individual *structural steel* shipping pieces.

Erection model. Three-dimensional digital model produced to convey the information necessary to erect the *structural steel*. This may be the same digital model as the *fabrication model*, but it is not required to be.

Erector. The entity that is responsible for the erection of the *structural steel*.

Fabrication documents. Shop drawings, *fabrication model*, or a combination of drawings and models.

Fabrication model. Three-dimensional digital model produced to convey the information necessary to fabricate the *structural steel*.

Fabricator. The entity that is responsible for detailing (except in Section 4.5) and fabricating the *structural steel*.

Hazardous materials. Components, compounds, or devices that are either encountered during the performance of the contract work or incorporated into it containing substances that, notwithstanding the application of reasonable care, present a threat of harm to persons or the environment.

Inspector. The *owner's* testing and inspection agency's representative.

Issued for construction. The *engineer of record's* designation that the *design documents* are authorized to be used to construct the steel structure depicted in the *design documents*, and that these *design documents* incorporate the information that is to be provided per the requirements of Section A4 of the AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360).

Issuing of design documents and specifications. The process by which the *owner's designated representative for design (ODRD)* delivers *design documents* and specifications for the purpose as designated and dated therein under contract to their client. See also *Releasing of design documents and specifications*.

Mill material. Steel mill products that are ordered expressly for the requirements of a specific project.

Other structures. Structures designed, fabricated, and erected in a manner similar to buildings, with building-like vertical and lateral load-resisting elements.

Owner. The entity that is identified as such in the *contract documents*.

Owner's designated representative for construction (ODRC). The *owner* or the entity that is responsible to the *owner* for the overall construction of the project, including its planning, quality, and completion. This is usually the general contractor, the construction manager, or similar authority at the jobsite.

Owner's designated representative for design (ODRD). The *owner* or the entity that is responsible to the *owner* for the overall structural design of the project, including the *structural steel* frame. This is usually the *structural engineer of record*.

Protected Zone. Areas of members or *connections* of members in which limitations apply to fabrication and attachments.

Released for construction. The term that describes the status of *contract documents* that are in such a condition that the *fabricator* and the *erector* can rely upon them for the performance of their work, including the ordering of material and the preparation of *shop* and *erection drawings* or *fabrication* and *erection models*.

Releasing of design documents and specifications. The process by which an *owner*, *ODRC*, or other party delivers *design documents* and *specifications* prepared by the *ODRD* for the purpose designated therein, to another party. See also *Issuing of design documents and specifications*.

Revision. An instruction or directive providing information that differs from information that has been *released for construction*. A *revision* may, but does not always, impact the cost or schedule of performance of the work.

Request for information (RFI). A written request for information or *clarification* generated during the construction phase of the project.

Shop drawings. Drawings of the individual *structural steel* shipping pieces that are to be produced in the fabrication shop.

Specifications. The portion of the *contract documents* that consists of the written requirements for materials, standards, and workmanship.

Standard structural shapes. Hot-rolled W-, S-, M-, and HP-shapes, channels, and angles listed in ASTM A6/A6M; structural tees split from the hot-rolled W-, S-, and M-shapes listed in ASTM A6/A6M; hollow structural sections produced to ASTM A500/A500M, A501/A501M, A618/A618M, A847/A847M, A1065/A1065M, or A1085/A1085M; and steel pipe produced to ASTM A53/A53M.

Steel detailer. The entity that produces the *approval documents*, *fabrication documents*, and *erection documents.*

Structural engineer of record (*SER*). The licensed professional who is responsible for sealing the *contract documents*, which indicates that he or she has performed or supervised the analysis, design, and document preparation for the structure and has knowledge of the load-carrying structural system.

Structural steel. The elements of the structural frame as given in Section 2.1.

Substantiating connection information. Information submitted by the *fabricator* in support of *connections* designed by the licensed *engineer* working for the *fabricator*.

Tier. The *structural steel* framing defined by a column shipping piece.

Transfer force. A force local to the intersection of structural members that is required to be transferred across that intersection through a *connection* and its elements to assure the continuity of the load path in a structural frame.

Upper finished splice line. The top surface of a column shipping piece . The top of the shipping piece does not include detail material such as splice plates or erection aids.

Weld show-through. In *architecturally exposed structural steel*, visual indication of the presence of a weld or welds on the side of the member opposite the weld.

Working points. *Work points*, or *working points*, are points that occur at the intersection of working lines. Working lines are the centerlines of members in trusses, beams, columns, or vertical and horizontal bracing, except in an unsymmetrical cross section for which the working line is the neutral axis. This definition does not apply to member work points and working lines as defined in Section 11.2.2.2 or Section 11.3 of *this Code*.

ABBREVIATIONS

The following abbreviations are used in this Code.

AASHTO (*American Association of State Highway and Transportation Officials*)

AESS (architecturally exposed structural steel)

AISC (American Institute of Steel Construction)

ANSI (American National Standards Institute)

AREMA (American Railway Engineering and Maintenance of Way Association)

ASD (allowable strength design)

ASME (American Society of Mechanical Engineers)

AWS (American Welding Society)

CAD (computer-aided design)

HSS (hollow structural section)

LRFD (load and resistance factor design)

ODRC (owner's designated representative for construction)

ODRD (owner's designated representative for design)

OSHA (Occupational Safety and Health Administration)

RCSC (Research Council on Structural Connections)

RFI (request for information)

SER (structural engineer of record)

CODE OF STANDARD PRACTICE FOR STEEL BUILDINGS AND BRIDGES

SECTION 1. GENERAL PROVISIONS

1.1. Scope

The *Code of Standard Practice for Steel Buildings and Bridges*, hereafter referred to as *the Code*, sets forth criteria for the trade practices involved in the design and construction of steel buildings, bridges, and *other structures*, and shall apply to all projects that involve fabricated *structural steel*. In the absence of specific instructions to the contrary in the *contract documents*, the trade practices that are defined in *this Code* shall govern the fabrication and erection of *structural steel*. Specific instructions to the contrary shall not violate any provisions of *applicable building codes*. The contract with the *fabricator* or *erector* shall identify by Code section number any specific instructions to the contrary not contained in the *design documents* or *specifications*. If specific instructions to the contrary have not been provided as required in this section, the provisions of *the Code* shall apply as written herein.

Commentary:
The practices defined in *this Code* are the commonly accepted standards of custom and usage for *structural steel* fabrication and erection, which generally represent the most efficient approach. Some provisions in *this Code* have been incorporated by reference into the International Building Code; see **www.aisc.org/303IBC**. These sections include, but are not limited to, (1) requirements for structural *design documents* and *specifications* issued for various purposes as defined in Section 3; (2) definition of structural steel as defined in Section 2.1; (3) consideration for initial system imperfections, including fabrication and erection tolerances, as set forth in Section 11; (4) surface preparation and painting requirements as set forth in Section 3; (5) *fabricator* and *erector* quality control requirements as set forth in Section 8; and (6) requirements for *fabricator* and *erector approval documents* as set forth in Section 4.

Reference is also made herein to AISC *Specification for Structural Steel Buildings* (ANSI/AISC 360-22) Section A4, which contains requirements for *design documents* and *specifications issued for construction*. ANSI/AISC 360 is incorporated by reference into the International Building Code (IBC) and is therefore part of the building code.

The Code is a copyrighted document and has important legal consequences. Its language has been carefully written to apply to the construction of steel buildings, bridges, and *other structures*. Some projects may warrant specific

modifications to Code provision(s) to suit project conditions. In such cases, any modifications to the specific language of *the Code* should be clearly set forth in the *contract documents.*

The Code is a balanced, consensus document written in a "party-neutral" manner and should not be modified for the purpose of dictating a commercial advantage. To that end, Section 1.1 requires any specific instructions to the contrary unrelated to design elements (e.g., relating to commercial terms) to include a reference to the specific Code section number. This requirement is intended to ensure that all parties are aware of and specifically agree to specific instructions to the contrary that may work to the advantage of one party and to the disadvantage of another.

Extreme care should be taken to ensure that any modification is written in mandatory code language where applicable and is consistent with all other sections of *the Code* to result in a unified document. No modifications should be made to any Code section that violates the life safety or serviceability provisions of the *applicable building code* or results in a commercial advantage for any party that violates the intention of *the Code* to serve as a fair, balanced consensus document.

A meeting is recommended with the project stakeholders, including the *owner's designated representative* for *construction* (*ODRC*), the *owner's designated representative for design* (*ODRD*), the *fabricator*, *erector*, and other parties, as appropriate, to discuss the scope of the project prior to the *design documents* and *specifications* being designated as *released for construction* as required by Section 3. This meeting can benefit the stakeholders in achieving a common understanding of the responsibilities and expectations of each party. Specifically, a discussion of any instructions to the contrary that modify any provisions of *the Code* that are applicable to the project and are included as part of the contract with the *fabricator* or *erector* should be clearly reviewed among the parties.

It is noted that *the Code* applies to all projects that involve fabricated *structural steel* regardless of what delivery method is selected by the *owner*. Refer to Section 3.2.

This Code is not intended to define a professional standard of care for the *owner's designated representative for design*; change the duties and responsibilities of the *owner*, contractor, *architect,* or *structural engineer of record* from those set forth in the *contract documents*; nor assign to the *owner*, *architect,* or *structural engineer of record* any duty or authority to undertake responsibility inconsistent with the provisions of the *contract documents*.

This Code is not applicable to steel joists or metal building systems, which are addressed by SJI and MBMA, respectively.

1.2. Dates of Referenced Specifications, Codes, and Standards

The following dated versions of documents are referenced in *this Code*:

AASHTO Specification—2020 AASHTO *LRFD Bridge Design Specifications*, 9th Edition

ANSI/AISC 341—ANSI/AISC 341-22, AISC *Seismic Provisions for Structural Steel Buildings*

ANSI/AISC 360—ANSI/AISC 360-22, AISC *Specification for Structural Steel Buildings*

ASME B46.1—ASME B46.1-19, Surface Texture (Surface Roughness, Waviness, and Lay)

AREMA Manual—2021 AREMA *Manual for Railway Engineering, Volume II—Structures, Chapter 15*

ASTM A6/A6M-19, *Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling*

ASTM A53/A53M-20, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM A500/A500M-21, *Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes*

ASTM A501/A501M-21, *Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing*

ASTM A572/A572M-21e1, *Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel*

ASTM A618/A618M-21, *Standard Specification for Hot-Formed Welded and Seamless High-Strength Low-Alloy Structural Tubing*

ASTM A847/A847M-20, *Standard Specification for Cold-Formed Welded and Seamless High-Strength, Low-Alloy Structural Tubing with Improved Atmospheric Corrosion Resistance*

ASTM A992/A992M-20, *Standard Specification for Structural Steel Shapes*

ASTM A1065/A1065/M-18, *Standard Specification for Cold-Formed Electric-Fusion (Arc) Welded High-Strength Low-Alloy Structural Tubing in Shapes, with 50 ksi [345 MPa] Minimum Yield Point*

ASTM A1085/A1085M-15, *Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS)*

AWS D1.1/D1.1M—AWS D1.1/D1.1M:2020, *Structural Welding Code—Steel*.

AWS D1.5M/D1.5—AWS D1.5M/D1.5:2020, *Bridge Welding Code*

AWS D1.8/D1.8M—AWS D1.8/D1.8M:2021, *Structural Welding Code—Seismic Supplement*

RCSC Specification—*Specification for Structural Joints Using High-Strength Bolts*, 2020

SSPC SP2—SSPC *Surface Preparation Specification No. 2, Hand Tool Cleaning*, 2018

Commentary:

Additionally, the following dated versions of documents are referenced in the Commentary on *this Code*:

AIA Document E202—2008 Building Information Modeling Protocol Exhibit
AIA Document E203—2013 Building Information Modeling and Digital Data Exhibit
AIA Document G201—2013 Project Digital Data Protocol Form
AIA Document G202—2013 Project Building Information Modeling Protocol Form
ASTM A563-15, *Standard Specification for Carbon and Alloy Steel Nuts*
ASTM A563M-07(2013), *Standard Specification for Carbon and Alloy Steel Nuts (Metric)*
ASTM F3125/F3125M-15, *Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions*
BIMFORUM 2013, Level of Development Specification
CASE Document 962—*National Practice Guidelines for the Structural Engineer of Record*, 2012
Consensus Docs 301—2013 BIM Addendum
OSHA *Safety and Health Regulations for Construction*—29 CFR 1926 Subpart R—Steel Erection
SSPC SP6—SSPC *Surface Preparation Specification No. 6, Commercial Blast Cleaning*, 2015

1.3. Units

In *this Code*, the values stated in either U.S. customary units or SI units shall be used. Each system shall be used independently of the other.

Commentary:
In *this Code*, dimensions, weights, and other measures are given in U.S. customary units with rounded or rationalized SI-unit equivalents in brackets. Because the values stated in each system are not exact equivalents, the selective combination of values from each of the two systems is not allowed by the code.

1.4 Responsibility for Identifying Contract Documents

The *owner's designated representative for construction* (*ODRC*) shall identify all *contract documents*. When the *design drawings* and a *design model* are both provided, the *owner's designated representative for design (ODRD)* shall specify which document is the controlling *contract document*. The *contract documents* shall establish the procedures for communicating changes to the *contract documents*, permitted use of design and other digital models, and restrictions on the release of these digital models to other parties.

Commentary:

There can be many combinations of drawings and digital models used as part of the *contract documents*, and to transfer information between the many entities in the design and construction processes. The communication of design information to the *fabricator* through the *design model* is permitted in *this Code*. *This Code* does not designate which of these possible documents takes precedence because of the variation in current practice. The document hierarchy is left to the *ODRD* and communicated through the *ODRC*. The *ODRC* must provide guidance as to which information is to be considered to have precedence if conflicts exist.

1.5. Design Criteria

For buildings and *other structures*, in the absence of other design criteria, the provisions in ANSI/AISC 360 shall govern the design of the *structural steel*. For bridges, in the absence of other design criteria, the provisions in the AASHTO Specification and AREMA Specification shall govern the design of the *structural steel*, as applicable.

1.6. Responsibility for Design

1.6.1. When the *ODRD* provides the design, *design documents*, and *specifications*, the *fabricator* and the *erector* are not responsible for the suitability, adequacy, or building-code conformance of the design.

1.6.2. When the *owner* enters into a direct contract with the *fabricator* to both design and fabricate an entire, completed steel structure, the *fabricator* shall be responsible for the suitability, adequacy, conformance with *owner*-established performance criteria, and building-code conformance of the *structural steel* design. The *owner* shall be responsible for the suitability, adequacy, and building-code conformance of the non-*structural steel* elements and shall establish the performance criteria for the *structural steel* frame.

1.7 Construction Schedule

The *ODRC* shall provide a construction schedule in the bid documents. The period of performance by the *fabricator* and *erector* shall be mutually agreed upon with the *ODRC* prior to contract award.

1.8. Patents and Copyrights

If patented or copyrighted products are specified, the responsibility for obtaining licensing and paying fees shall be set forth in the contract documents.

1.9. Existing Structures

1.9.1. Demolition and shoring of any part of an existing structure are not within the scope of work that is provided by either the *fabricator* or the *erector*. Such demolition and shoring shall be performed in a timely manner so as not to interfere with or delay the work of the *fabricator* or the *erector*.

1.9.2. Protection of an existing structure and its contents and equipment, to prevent damage from normal erection processes, is not within the scope of work that is provided by either the *fabricator* or the *erector*. Such protection shall be performed in a timely manner so as not to interfere with or delay the work of the *fabricator* or the *erector*.

1.9.3. Surveying or field dimensioning of an existing structure is not within the scope of work that is provided by either the *fabricator* or the *erector*. Such surveying or field dimensioning, which is necessary for the completion of the *approval documents* and fabrication, shall be performed and furnished to the *fabricator* in a timely manner so as not to interfere with or delay the work of the *fabricator* or the *erector*.

1.9.4. Abatement or removal of *hazardous materials* is not within the scope of work that is provided by either the *fabricator* or the *erector*. Such abatement or removal shall be performed in a timely manner so as not to interfere with or delay the work of the *fabricator* or the *erector*.

1.10. Means, Methods, and Safety of Erection

1.10.1. The *erector* shall be responsible for the means, methods, and safety of erection of the *structural steel* frame.

1.10.2. The *structural engineer of record* (*SER*) shall be responsible for the structural adequacy of the design of the structure in the completed project. The *SER* shall not be responsible for the means, methods, and safety of erection of the *structural steel* frame. See also Section 7.10.

Commentary:
The *erector* normally establishes the methods and sequence of the work for the erection process, including the safety of the personnel involved in these activities. Special requirements should be included in the bid documents when another party prescribes erection means and methods. The *erector* is also in control of the stability of the structure during this activity. A site-specific or project-specific erection plan and erection bracing drawings can provide the work plan and control mechanisms to maintain safety for personnel and structural stability during erection. Erection Bracing Drawings are prepared by the erector to illustrate the sequence of erection, any requirements for temporary

supports, and the requirements for raising, bolting, and welding. These drawings are in addition to the erection drawings. The *ODRC*, per OSHA 29 CFR 1926 Subpart R—Steel Erection, provides information and support to the *erector* to assure safety and structural stability. The *ODRD* provides the required information related to structural stability as required by Section 7.10.1.

1.11. Tolerances

Tolerances for materials, fabrication, and erection shall be as stipulated in Sections 5, 10, and 11. Tolerances absent from *this Code* or the *contract documents* shall not be considered zero by default.

Commentary:
Tolerances are not necessarily specified in *this Code* for every possible variation that could be encountered. For most projects, where a tolerance is not specified or covered in *this Code*, it is not needed to ensure that the fabricated and erected *structural steel* complies with the requirements in Section 11. If a special design concept or system component requires a tolerance that is not specified in *this Code*, the necessary tolerance should be specified in the *contract documents*. If a tolerance is not shown and is deemed by the *fabricator* or *erector* to be important to the successful fabrication and erection of the *structural steel*, it should be requested from the *owner's designated representative for design*. The absence of a tolerance in *this Code* for a particular condition does not mean that the tolerance is zero; rather, it means that no tolerance has been established. In any case, the default tolerance is not zero.

1.12. Marking of Protected Zones in Seismic Force-Resisting Systems

The *fabricator* shall permanently mark *protected zones* that are designated on the structural *design documents* in accordance with ANSI/AISC 341, Section A4.2. If these markings are obscured in the field, such as after the application of fire protection, the *ODRC* shall re-mark the *protected zones* as they are designated on the structural *design documents*.

Commentary:
Protected zones are defined by ANSI/AISC 341 and specified in *Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications* (ANSI/AISC 358) for each type of seismic force-resisting system (SRFS) and are required to be shown on the design drawings. The *ODRC* uses this information to control construction activities in these regions and prevent prohibited attachments in the *protected zones*. Where SFRS members with protected zones markings are exposed in the finished construction and covered by finish paint, the *ODRC* should notify the *owner* which *protected zones* have been painted over to help guard against prohibited attachments in the future.

1.13. Sustainability Requirements

Where sustainability requirements are identified by the owner or their agents, including when the sustainability requirements are jurisdictionally mandated, they shall be specified in the *contract documents*. Submittal requirements, if any, shall be specified in the *contract documents*. The *fabricator's* identification system for material shall demonstrate compliance.

Commentary:

Sustainability requirements may be specified by the owner or mandated by municipal, state, or federal law. The latter case is usually referred to as a Buy Clean requirement.

Such requirements can take many forms. Two common options are a requirement for a minimum recycled content or a limit on Global Warming Potential (GWP). Documents used to demonstrate compliance are mill-authored recycled content letters and Environmental Product Declarations (EPDs), respectively.

Not all available material will meet a given sustainability requirement. For this reason, it is critical that the fabricator know what requirements apply prior to the purchase of material so that compliant material can be purchased. It is equally important to state what submittals, if any, are required from the fabricator to confirm compliance.

GWP is a measure of how much energy the collective emissions of various greenhouse gasses will absorb in the atmosphere over a period of time (typically 100 years), relative to the emissions of carbon dioxide. This creates an equivalent measure of carbon dioxide, which is termed CO2e. For structural steel, GWP is commonly reported within an EPD in dimensionless units, such as (tons CO2e / tons steel) or (kg CO2e / kg steel).

An EPD is a transparent statement of environmental performance that is determined by a life cycle assessment. Most are of the type III form in conformance with ISO 14025. A comprehensive summary of publicly available EPDs for domestic structural steel products is maintained at www.aisc.org/epd.

SECTION 2. CLASSIFICATION OF MATERIALS

2.1. Definition of Structural Steel

Structural steel shall consist of the elements of the structural frame that are shown and sized in the structural *design documents*, essential to support the design loads and described as follows:

Anchor rods that will receive *structural steel*
Base plates, if part of the *structural steel* frame
Beams, including built-up beams, if made from *standard structural shapes* or plates
Bearing plates, if part of the *structural steel* frame
Bearings of steel for girders, trusses, or bridges
Bracing, if permanent
Canopy framing, if made from *standard structural shapes* or plates
Columns, including built-up columns, if made from *standard structural shapes* or plates
Connection materials for framing *structural steel* to *structural steel*
Crane stops, if made from *standard structural shapes* or plates
Door frames, if made from *standard structural shapes* or plates and if part of the *structural steel* frame
Edge angles and plates, if attached to the *structural steel* frame or steel (open-web) joists
Embedded *structural steel* parts, other than bearing plates, that will receive *structural steel*
Expansion joints, if attached to the *structural steel* frame
Fasteners for connecting *structural steel* items: permanent shop bolts, nuts, and washers; shop bolts, nuts, and washers for shipment; field bolts, nuts, and washers for permanent *connections*; and permanent pins
Floor-opening frames, if made from *standard structural shapes* or plates and attached to the *structural steel* frame or steel (open-web) joists
Floor plates (checkered or plain), if attached to the *structural steel* frame
Girders, including built-up girders, if made from *standard structural shapes* or plates
Girts, if made from *standard structural shapes*
Grillage beams and girders
Hangers, if made from *standard structural shapes*, plates, or rods and framing *structural steel* to *structural steel*
Leveling nuts and washers
Leveling plates
Leveling screws
Lintels, if attached to the *structural steel* frame

Machinery supports, if made from *standard structural shapes* or plates and attached to the *structural steel* frame
Marquee framing, if made from *standard structural shapes* or plates
Monorail elements, if made from *standard structural shapes* or plates and attached to the *structural steel* frame
Posts, if part of the *structural steel* frame
Purlins, if made from *standard structural shapes*
Relieving angles, if attached to the *structural steel* frame
Roof-opening frames, if made from *standard structural shapes* or plates and attached to the *structural steel* frame or steel (open-web) joists
Roof-screen support frames, if made from *standard structural shapes*
Sag rods, if part of the *structural steel* frame and connecting *structural steel* to *structural steel*
Shear stud connectors, if specified to be shop attached
Shims, if permanent
Steel plate shear walls, composite steel plate shear wall systems, and steel plate structures, if made from standard shapes or plates and if part of the *structural steel* frame
Struts, if permanent and part of the *structural steel* frame
Tie rods, if part of the *structural steel* frame
Trusses, if made from *standard structural shapes* or built-up members
Wall-opening frames, if made from *standard structural shapes* or plates and attached to the *structural steel* frame
Wedges, if permanent

Commentary:
The *fabricator* normally fabricates the items listed in Section 2.1. Such items should be shown, sized, and described in the structural *design documents*. Bracing includes vertical bracing for resistance to wind and seismic load and structural stability, horizontal bracing for floor and roof systems, and permanent stability bracing for components of the *structural steel* frame.

2.2. Other Steel, Iron, or Metal Items

Structural steel shall not include other steel, iron, or metal items that are not generally described in Section 2.1, even where such items are shown in the structural *design documents* or are attached to the *structural steel* frame. Other steel, iron, or metal items include, but are not limited to, the following:

Base plates, if not part of the *structural steel* frame
Bearing plates, if not part of the *structural steel* frame
Bearings, if nonsteel
Cables for permanent bracing or suspension systems
Castings

Catwalks
Chutes
Cold-formed steel products
Cold-rolled steel products, except those that are specifically covered in ANSI/AISC 360
Corner guards
Crane rails, splices, bolts, and clamps
Crane stops, if not made from *standard structural shapes* or plates
Door guards
Embedded steel parts, other than bearing plates, that do not receive *structural steel* or that are embedded in precast concrete
Expansion joints, if not attached to the *structural steel* frame
Flagpole support steel
Floor plates (checkered or plain), if not attached to the *structural steel* frame
Forgings
Gage-metal products
Grating
Handrail
Hangers, if not made from *standard structural shapes*, plates, or rods, or not framing *structural steel* to *structural steel*
Hoppers
Items that are required for the assembly or erection of materials that are furnished by trades other than the *fabricator* or *erector*
Ladders
Lintels, if not attached to the *structural steel* frame
Masonry anchors
Ornamental metal framing
Other miscellaneous metal not already listed
Pressure vessels
Reinforcing steel for concrete or masonry
Relieving angles, if not attached to the *structural steel* frame
Roof screen support frames, if not made from *standard structural shapes*
Safety cages
Shear stud connectors, if specified to be field installed
Stacks
Stairs
Steel deck
Steel (open-web) joists
Steel joist girders
Steel used as piling or piling accessories
Tanks
Toe plates
Trench or pit covers

Commentary:

Section 2.2 includes many items that may be furnished by the *fabricator* if contracted to do so by specific notation and detail in the *contract documents*. When such items are contracted to be provided by the *fabricator*, coordination will normally be required between the *fabricator* and other material suppliers and trades. The provisions in *this Code* are not intended to apply to items in Section 2.2.

In previous editions of *this Code*, provisions regarding who should normally furnish field-installed shear stud connectors and cold-formed steel deck support angles were included in Section 7.8. These provisions have been eliminated since field-installed shear stud connectors and steel deck support angles are not defined as *structural steel* in *this Code*.

Stainless steel is not covered in *this Code*. AISC 370, AISC 313, and Design Guide 27, *Structural Stainless Steel*, are sources of useful information regarding the practical fabrication and installation issues associated with structural stainless steel components.

SECTION 3. DESIGN DOCUMENTS AND SPECIFICATIONS

The *issuing of design documents and specifications* shall be by the *owner's designated representative for design* (*ODRD*). The *releasing of design documents and specifications* shall be by an *owner*, *owner's designated representative for construction* (*ODRC*), or other party. *Design documents* and *specifications* shall be released in accordance with Section A4.2 of ANSI/AISC 360.

Commentary:
Refer to the ANSI/AISC 360, Commentary Section A4.2, for guidelines related to the issuance and release of *design documents* and *specifications* on a project.

3.1. Structural Design Documents and Specifications Issued for Construction

Structural *design documents* and *specifications issued for construction*, also known as *construction documents*, for all or a portion of the work shall be based upon a completed design for the scope of work represented and provide the following information, as applicable, to define the work to be fabricated and erected:

(a) Information as required by the *applicable building code*.
(b) Information as required in ANSI/AISC 360 Section A4 and ANSI/AISC 341 Section A4.
(c) Shop painting and surface preparation requirements. Specific members or portions thereof that are to be left unpainted shall be identified. When shop painting is required, the paint system requirements shall be specified, including (1) the identification of specific members or portions thereof to be painted; (2) the surface preparation that is required for these members; (3) the paint *specifications* and manufacturer's product identification, including color requirements, if any, that are required for these members; (4) the minimum dry-film shop-coat thickness that is required for these members; (5) identification of compatible shop applied and field applied paint systems in multi-coat application; and (6) the party or subcontractor responsible for field touch-up including repair of shipping and handling damage after shop application(s). The absence of the foregoing information for bidding purposes shall result in provisions for related work to be absent from the bid. When the actual information becomes available subsequent to bidding, the contract price and schedule shall be adjusted equitably in accordance with Sections 9.4 and 9.5
(d) Designation of members to which the requirements of Section 10 for *architecturally exposed structural steel (AESS)* apply.
(e) Where leveling plates are to be furnished, their locations and required thickness and sizes.

The structural *design documents*, *specifications*, and addenda shall be numbered and dated for the purposes of identification. Three-dimensional digital models shall contain a unique identifier.

Commentary:

In the interests of public safety, structural *design documents* and *specifications issued for construction* for all or a portion of the work are required to be based upon a completed design for the scope of work represented. The items listed should include contractual requirements addressed in *the Code*.

The *engineer of record* should also consider all or a portion of the specified information to be shown on structural *design documents* and *specifications* used for ordering *structural steel* or placing mill orders. Changes made after ordering *structural steel* or placing mill orders will likely lead to change orders if not properly coordinated and addressed in a timely manner prior to construction. *Revisions* to the *design documents* and *specifications* are covered under Section 3.6.

In some cases, the *owner* can benefit when reasonable latitude is allowed in the *contract documents* for alternatives that can reduce costs without compromising quality. However, critical requirements that are necessary to protect the *owner's* interests that affect the integrity of the structure or that are necessary for the *fabricator* or *erector* to proceed with their work should be explicitly included in the *contract documents issued for construction*. A list of important information and requirements are provided to supplement items required for documents *issued for construction* in ANSI/AISC 360. This list should be modified or supplemented, if necessary, to suit actual project conditions.

Some members or portions thereof may be required to be left unpainted, such as those that will be in contact and acting compositely with concrete, those areas near or within *connections*, or those that will receive spray-applied fire protection materials. The *contract documents* should clearly indicate where the change in finishes start and stop so there is no confusion between all parties.

This section refers directly to "painting". The *contract documents* should clearly state its applicability to other coatings, such as intumescent paint, i.e., fireproofing.

This section applies to shop painting. If project requirements are to include field painting, these requirements should be explicitly identified in the *contract documents*; see Section 7.17. SSPC *Painting Manual*, Volumes 1 and 2, 5th Edition is a useful reference for coatings and painting.

The surface preparation used for a paint system should carefully consider the intended use of the steel (i.e., interior, exterior, *AESS*, etc.) as it affects both the aesthetics of surface irregularities and durability against paint failure. For most interior commercial applications, durability is not normally a concern as

discussed in the ANSI/AISC 360, Commentary Section M3. However, if surface irregularities from mill scale, whether coated or not, or accumulated rust would be visually objectionable, then an SP6 preparation should be considered because a less aggressive preparation will not remove all tightly adhered mill scale and may not remove all rust from material stored outside. A mockup can be useful to demonstrate the impact of an SP6 preparation on surface irregularities.

For interior corrosive environments and exterior applications, an SP6 preparation is generally regarded as the minimum level of preparation necessary to provide adequate durability against paint failure. However, for other types of coatings (e.g., hot dip galvanizing), that may not be the case.

3.2. Structural Design Documents and Specifications Issued as Contract Documents

3.2.1. Traditional Design-Bid-Build Delivery Method

For a traditional design-bid-build delivery method, structural *design documents* and *specifications* issued as the basis for *contract documents* shall provide the information as specified in Section 3.1 for structural *design documents* and *specifications issued for construction*.

3.2.2. Alternate Delivery Methods

For alternative delivery methods, when structural *design documents* and *specifications* not meeting all the listed requirements of Section 3.2.1 are issued as *contract documents*, the listed information not specified shall be acknowledged in the contract with the *fabricator* and the *erector*. The *contract documents* shall convey the character, quantity, and complexity of the *structural steel* to be fabricated and erected so that the *fabricator* and *erector* can provide bids that are accurate and complete. The information furnished shall include the following items as minimum requirements:

(a) The section, size, material grade, and location of members.
(b) Geometry and work points necessary for layout.
(c) Column base, floor, and roof elevations.
(d) Column centers and offsets.
(e) When the requirements of ANSI/AISC 341 are applicable, the information required in ANSI/AISC 341, Section A4.
(f) The lateral force-resisting system and connecting diaphragm elements that provide for lateral strength and stability in the completed structure.
(g) Requirements for all *connections* and member reinforcement as required by Sections 3.2.3 and 3.2.4. For *connections* that are delegated by Option 3, the *engineer of record* shall provide project-specific schematic *connection*

details for all *connection* types based on realistic design forces to define the design intent and sufficient information for the delegated *connection* designer (the licensed *engineer* to whom the work is delegated) to understand the scope and nature of the delegated work and its relationship to the overall design. The information that is required to perform the delegated design shall be commensurate with the character and complexity of the project.

Where any of the information required for a complete design as defined in Section 3.1 for *design documents* and *specifications issued for construction* is not specified, including member reinforcement and *connections* that are delegated with Section 3.2.3, Option 3, *allowances* shall be specified in the contract and the provisions of Section 9.1.5 shall apply.

When the actual quantity or details of any of the required items differ from the specified *allowances*, including *connections* and all member reinforcement where delegated with Section 3.2.3, Option 3, the final contract price and schedule shall be adjusted equitably in accordance with Section 9.1.5.

When an alternative project delivery method is selected, release of the structural *design documents* and *specifications* shall constitute a release for the purpose stated on the *design documents* and *specifications* that were issued by the *ODRD*, as specified in Section 3, regardless of the status of the architectural, electrical, mechanical, and other interfacing designs and *contract documents*. Subsequent *revisions*, if any, released after the *design documents* and *specifications* are *released for construction*, shall be the responsibility of the *owner* and shall be made in accordance with Sections 3.6 and 9.3.

Commentary:
The Code has been modified to clarify the requirements for *design documents* and *specifications issued for construction* (refer to the Glossary for the definition of *issued for construction*) and issued for *contract documents* (*design drawings*, *digital model* where applicable, *specifications*, and the contract with the *fabricator* or *erector*). Documents *issued for construction* for all or a portion of the work are subject to the requirements of Section 3.1. *Design documents* issued as the basis of a contract for *structural steel* fabrication and erection are covered in a new Section 3.2. Section 3.2 now addresses all the items formerly located in Sections 3.1.1 and 3.1.2 of the 2016 Code, including member reinforcement (such as stiffeners, web doubler plates, and beam bearing stiffeners) away from *connections* and at locations of *connections*. Any of these items, or other items that are not defined on partially complete documents issued for *contract documents* as stated in Section 3.2.2 for alternate delivery methods, should be treated as an *allowance* by the various stakeholders to a contract. The requirements for an *allowance* are covered in Section 9.1.5, including the commentary, which further explains their purpose and application.

Contract documents can vary greatly in complexity and completeness depending on the delivery method utilized for the project. Nonetheless, the *fabricator* and *erector* must be able to rely upon the accuracy and completeness of the *contract documents* for bidding. This allows the *fabricator* and *erector* to provide the *owner* with bids that are adequate and complete.

This section lists the minimum requirements for *contract documents*. If partially complete documents are issued for *contract documents*, the parties (including, but not limited to, the *owner, owner's representatives for design* and construction, the *fabricator*, and *erector*) should collaborate to reach mutual agreement on what information is not specified and document in writing what *allowances* are to be included with appropriate contingencies for the uncertainty (including *allowances* for member reinforcement and *connections* where Option 3 is specified). Any contracts can then be executed according to the provisions of Section 9.1.5 for reconciliation by change order after the design of the missing information is completed. Refer to Commentary Section 9.1.5.

Alternative project delivery methods other than the traditional design-bid-build method generally provide for a condensed schedule for the design and construction of a project in an effort to reduce overall cost of a project. The *owner* elects to *release for construction* the structural *design documents* and *specifications*, which may be partially complete, at a time that may precede the completion of and coordination with architectural, mechanical, electrical, and other design work and *contract documents*. The release of the structural *design documents* and *specifications* may also precede the release of the General Conditions and Division 1 Specifications.

Release of the structural *design documents* and *specifications* to the *fabricator* for ordering of material constitutes a *release for construction*. Accordingly, the *fabricator* and the *erector* may begin their work based upon those partially complete documents. As the structural, architectural, mechanical, electrical, and other *design documents* for the project are completed, *revisions* are likely required in design or construction. Thus, when considering these alternative project delivery methods, the *owner* should evaluate the potential benefits to the project schedule and cost along with the added cost of changes that are likely to occur. A project cost contingency is necessary to allow for these subsequent changes. The potential cost savings to the project is net of the cost of these design and construction changes.

3.2.3. Requirements for Connections

The *ODRD* shall indicate one of the following options for each *connection*:

(1) Option 1: The complete *connection* design shall be shown in the structural *design documents*.
(2) Option 2: The *connection* shall be designated in the structural *design documents* or *specifications* to be selected or completed by a *steel detailer*.

The *steel detailer* shall utilize reference information provided in the *design documents* in the selection or completion of the *connections*. A list of other reference information, if any, provided by the *steel detailer* shall be approved by the *ODRD*.

(3) Option 3: The *connection* shall be designated in the structural *design documents* or *specifications* to be designed by a licensed *engineer* working for the *fabricator*. The following additional requirements apply:

(a) *Substantiating connection information* shall be provided for Option 3.

(b) The *fabricator* shall submit in a timely manner representative samples of the required *substantiating connection information* for all types of *connections* in the *structural steel* frame to the *ODRD*. The *ODRD* shall confirm in writing in a timely manner that these representative samples are consistent with the requirements of the *contract documents*, or shall advise what modifications are required to bring the representative samples into compliance with the requirements of the *contract documents*. This initial submittal and review is in addition to the requirements in Section 4.4.

(c) The licensed *engineer* in responsible charge of the *connection* design shall review and confirm in writing as part of the *substantiating connection information*, that the *approval documents* properly incorporate the *connection* designs. However, this review by this licensed *engineer* in responsible charge of the *connection* design does not replace the approval process of the *approval documents* by the *ODRD* in Section 4.4.

(d) The *fabricator* shall provide a means by which the *substantiating connection information* is referenced to the related *connections* on the *approval documents* for the purpose of review.

When Option 2 or 3 is specified, the *owner's designated representative for design* shall provide the following *connection* design criteria in the structural *design documents* and *specifications*:

(a) Project specific *connection* details that show the conceptual configuration for the order of magnitude forces to be transferred

(b) Any restrictions on the types of *connections* that are permitted

(c) Data concerning the loads including shears, moments, axial forces, and *transfer forces* that are resisted by the individual members and their *connections*, sufficient to allow selection, completion, or design of the *connection* details while preparing the *approval documents*

(d) Whether the data required in (c) is given at the service-load level or the factored-load level

(e) Whether LRFD or ASD is to be used in the selection, completion, or design of *connection* details

(f) What *substantiating connection information* is to be provided with the *approval documents* to the *ODRD*

(g) For *adjustable items*, all locations and criteria necessary for the proper position and alignment of the structure and supports for other trades, including the required direction(s) and range of the adjustment necessary in each direction.

(h) For embedded items and connection materials that are part of the work of other trades, but that will receive structural steel, all criteria necessary to account for industry tolerances in the work of these other trades so the structural steel frame can be erected in conformity with the tolerances specified in Section 11.3.

In all three of the preceding options, the approval process in Section 4.4 shall be followed.

Commentary:

This section requires the *ODRD* to indicate one of three options for each connection in the project to clearly communicate the *fabricator's* scope of work for connections. It is acceptable to group connections by type and to utilize a combination of these options for the various connection types involved in a project.

(1) In Option 1, the *ODRD* shows the complete design of the *connections* in the structural *design documents*. The following information is included:

(a) All work point locations and *connection* geometry
(b) All plate and angle sizes, thicknesses, dimensions, and material grades
(c) All weld types, sizes, lengths, locations, and strengths
(d) All bolt sizes, grades, locations, and quantities
(e) Member setback distances from the specified work point
(f) Surface preparation at faying surfaces for bolting or for corrosion protection
(g) Any member end preparation required such as copes, blocks, cuts, or chipping
(h) In seismic applications, the information specified in ANSI/AISC 341, Section A4.2
(i) Any member reinforcement required at *connections* (see Section 3.2.4)
(j) Consideration of all applicable strength limit states
(k) Consideration of fit-up and constructability
(l) Any other items required for consideration in the particular *connection* design and detailing so that a *steel detailer* can detail the *connection* on the *fabrication documents*

The intent of this approach is that complete design information necessary for detailing the *connection* is shown in the structural *design documents*. Typical details are shown for each *connection* type, set of geometric parameters, and adjacent framing conditions. The *steel detailer* will then be able to transfer this information to the *approval documents*, applying it to the individual pieces being detailed.

(2) In Option 2, the *ODRD* allows a *steel detailer* to select or complete the *connections*. This is commonly done by referring to loads embedded in the digital model, tables or schematic information in the structural *design documents*, tables in the AISC *Steel Construction Manual*, or other reference information approved by the *ODRD*, such as journal papers and recognized software output. Tables and schematic information in the structural *design documents* should provide such information as weld types and sizes, plate thicknesses, and quantities of bolts. However, there may be some geometry and dimensional information that the *steel detailer* must develop. The *steel detailer* will then configure the *connections* based upon the design loads and other information given in the structural *design documents* and *specifications*.

The intent of this method is that the *steel detailer* will select the *connection* materials and configuration from the referenced tables or complete the specific *connection* configuration (e.g., dimensions, edge distances and bolt spacing) based upon the *connection* details that are shown in the structural *design documents*.

A suitable *steel detailer* will be experienced and familiar with AISC requirements for *connection* configurations, the use of the *connection* tables in the AISC *Steel Construction Manual*, the calculation of dimensions, and adaptation of typical *connection* details to similar situations. Notations of loadings in the structural *design documents* are only to facilitate selection of the *connections* from the referenced tables. It is not the intent that this method be used when the practice of engineering is required.

(3) Option 3 reflects the practice to have a licensed *engineer* working for or retained by the *fabricator* design the *connections*, and recognizes the information required by the *fabricator* to do this work. The *ODRD*, who has the knowledge of the structure as a whole, is responsible for reviewing and approving the *approval documents*, and the *substantiating connection information* that is requested. See Section 4.4 for the approval process.

When, under Section 3.2.3, the *ODRD* designates that *connections* are to be designed by a licensed *engineer* employed or retained by the *fabricator*, this work is incidental to, and part of the requirements for fabricating and constructing the steel frame. The licensed *engineer* performing the *connection* design is not providing a peer review of the *contract documents*.

The *ODRD* reviews the *approval documents* during the approvals process as specified in Section 4.4 for conformance with the specified criteria and compatibility with the design of the primary structure.

Option 3 is not normally specified for *connections* that can be selected or completed as noted in Option 2. Substantiating connection information is only required in Option 3.

If there are any restrictions as to the types of *connections* to be used, it is required that these limitations be set forth in the structural *design documents* and *specifications*. There are a variety of *connections* available in the AISC *Steel Construction Manual* for a given situation. Preference for a particular type will vary between *fabricators* and *erectors*. Stating these limitations, if any, in the structural *design documents* and *specifications* will help to avoid repeated changes to the *approval documents* due to the selection of a *connection* that is not acceptable to the *ODRD*, thereby avoiding additional cost and/or delay for revising the *approval documents*.

For Option 2 and Option 3, the structural design documents are required to indicate the design loads for *connections* including *transfer forces*. *Transfer forces* can be determined using the *connection* geometry and statics for an individual load combination. However, *transfer forces* are required to be explicitly provided by the *engineer of record* when *connection* design loads are provided as maximum and minimum member forces resulting from more than one load combination or resulting from prescriptive rules provided in the *contract documents*.

The uniform load tables found in Part 3 of the AISC *Steel Construction Manual* should not be used when establishing design loads for connections in design documents and specifications. The inappropriateness of this method is discussed in detail in AISC *Steel Construction Manual* Part 2. When the use of the uniform load tables results in an overestimation of the connection design loads, unnecessary connection costs are the consequence. When the use of the uniform load tables results in an underestimation of the correct connection design load, unsafe connections are the potential consequence. The second condition cannot be allowed to occur, as life safety may be compromised.

The structural *design documents* are required to indicate the method of design used as LRFD or ASD. In order to conform to the spirit of ANSI/AISC 360, the *connections* should be selected using the same design method and the corresponding references.

Substantiating connection information can take many forms. When Option 2 is designated, the *approval documents* may suffice unless additional information is requested by the *engineer of record*. When Option 3 is designated, the *substantiating connection information* is required and may take the form of hand calculations, software output, or any additional information as requested by the *ODRD*.

When *substantiating connection information* is required, it is required that representative samples of that information be agreed upon prior to preparation of the *approval documents*, in order to avoid additional cost and delay for the *connection* redesign or revising that might otherwise result.

The *ODRD* may require that the *substantiating connection information* be signed and sealed for Option 3. The signing and sealing of the cover letter transmitting the *approval documents* and *substantiating connection information* may suffice. This signing and sealing indicates that a licensed *engineer* performed the work but does not replace the approval process provided in Section 4.4.

A requirement to sign and seal each sheet of the *shop* and *erection drawings* is discouraged as it may serve to confuse the design responsibility between the *ODRD* and the licensed *engineer's* work in performing the *connection* design. Such a requirement may not be possible when submitting *fabrication* and *erection models*.

3.2.4. Requirements for Member Reinforcement

(1) At locations away from *connections*, stiffeners, web doubler plates, bearing stiffeners, and all other member reinforcement, where required, shall be designed by the *ODRD* and shown in sufficient detail in the structural *design documents* so that the quantity, detailing, and fabrication requirements for these items can be readily understood.

(2) At locations of *connections*, the following requirements shall apply to column stiffeners, web doubler plates, beam bearing stiffeners, and all other member reinforcement required to satisfy strength and equilibrium of forces through the *connection*:

(a) These items, if required, shall be designed by the *ODRD* and shown in the structural *design documents* so that the quantity, detailing, and fabrication requirements can be readily understood, or

(b) Where *connections* and member reinforcement are specified to be designed by a licensed *engineer* working for the *fabricator*, the *ODRD* shall provide project-specific schematic details for member reinforcement with sufficient information for a *fabricator* to obtain an accurate bidding quantity and any limitations regarding the type and connection of member reinforcement. If no quantities or conceptual configurations are shown, member reinforcement at *connections* will not be included in the bid.

Commentary:

When considering member reinforcement, Option 3 is most useful when the *ODRD* delegates the *connection* design, but has selected members to eliminate

or minimize the need for member reinforcement at *connections*. Alternatively, the *design documents* should specify that the determination and design of member reinforcement at *connections* is delegated to the licensed *engineer* working for the *fabricator*. In such cases, the *ODRD* is required to provide schematic details for member reinforcement with sufficient information for bidding.

When no quantities and details are shown for column stiffeners, web doubler plates, beam bearing stiffeners, or other member reinforcement required to satisfy strength and equilibrium of forces through *connections*, the *fabricator's* bid reflects no *allowance* for these items. Should it subsequently be determined that member reinforcement at *connections* is required, the provisions of Sections 9.4 and 9.5 then apply.

3.3. Architectural, Electrical, and Mechanical Design Documents and Specifications

All requirements for the quantities, sizes, and locations of *structural steel* shall be shown or noted in the structural *design documents*. The structural *design documents* are permitted to reference the architectural, electrical, and/or mechanical *design documents* as a supplement to the structural *design documents* for the purposes of defining detail configurations and construction information.

When the referenced information is not available at the time of structural design, bidding, detailing, or fabrication, subsequent *revisions* shall be the responsibility of the *owner* and shall be made in accordance with Sections 3.6 and 9.3.

3.4. Discrepancies

When discrepancies exist between the *design documents* and *specifications*, the *design documents* shall govern. When discrepancies exist between scale dimensions in the *design documents* and the figures written in them, the figures shall govern. When discrepancies exist between the structural *design documents* and the architectural, electrical, or mechanical *design documents*, or the *design documents* for other trades, the structural *design documents* shall govern. When discrepancies exist between the *design drawings* and the *design model*, the governing document shall be as identified per Section 1.4.

When a discrepancy is discovered in the *contract documents* in the course of the *fabricator's* work, the *fabricator* shall promptly notify the *ODRC* so that the discrepancy can be resolved. Such resolution shall be timely so as not to delay the *fabricator's* work. See Sections 3.6 and 9.3.

It is not the *fabricator's* responsibility to discover discrepancies, including those that are associated with the coordination of the various design disciplines.

3.5. Legibility of Design Drawings

Design drawings shall be clearly legible and drawn to an identified scale that is appropriate to clearly convey the information.

Commentary:
Historically, the most commonly accepted scale for *structural steel* drawings has been 1/8 in. per ft (10 mm per 1 000 mm). There are, however, situations where a smaller or larger scale is appropriate. Ultimately, clarity of the drawing governs selection of scale.

The scaling of the *design drawings* to determine dimensions is not an accepted practice for detailing the *approval documents*. However, it should be remembered when preparing *design drawings* that scaling may be the only method available when early-submission drawings are used to determine dimensions for estimating and bidding purposes.

3.6. Revisions to the Design Documents and Specifications

Revisions to the *design documents* and *specifications* shall be made either by issuing new *design documents* and *specifications* or by reissuing the existing *design documents* and *specifications*. In either case, all *revisions*, including *revisions* that are communicated through responses to *requests for information (RFI)* or the annotation of the *approval documents* (see Section 4.4.2), shall be clearly and individually indicated in the *contract documents*. The *contract documents* shall be dated and identified by *revision* number. When the *design documents* are communicated using *design drawings*, each *design drawing* shall be identified by the same drawing number throughout the duration of the project, regardless of the *revision*. See also Section 9.3.

When *revisions* are communicated using *design models*, *revisions* shall be made evident in the revised *design model* submitted by identifying within the *design model* which items are changed. Alternatively, the changes shall be submitted with a written document describing in explicit detail the items that are changed. A historic tracking of changes must either be present in the revised *design model* or maintained in the written record of changes.

The party or entity that is contractually assigned responsibility for managing the *design model* shall maintain accurate accounting and tracking records of the most current *design model*, as well as previously superseded *design models*, and shall facilitate a tracking mechanism so that all contracted parties are aware of, and have access to, the most current *design model*.

Commentary:
Revisions to the *design documents* and *specifications* can be made by issuing sketches and supplemental information separate from the *design documents* and *specifications*. These sketches and supplemental information become amendments to the *design documents* and *specifications* and are considered new

contract documents. All sketches and supplemental information should be uniquely identified with a number and date as the latest instructions until such time as they may be superseded by new information.

When *revisions* are made by revising and reissuing the existing structural *design documents* or *specifications*, a unique *revision* number and date should be added to those documents to identify that information as the latest instructions until such time as they may be superseded by new information. When the *design documents* are communicated using *design drawings*, the same unique drawing number should identify each *design drawing* throughout the duration of the project so that *revisions* can be properly tracked, thus avoiding confusion and miscommunication among the various entities involved in the project.

When *revisions* are communicated through the annotation of the *approval documents* or contractor submissions, such changes must be confirmed in writing by one of the aforementioned methods. This written confirmation is imperative to maintain control of the cost and schedule of a project and to avoid potential errors in fabrication.

When *design models* are used, a similar unique method of identifying each *revision* should be used. This method can vary in various digital modeling software, but the same level of notation of changes should be present in the revised *design model* as would be used on *design drawings.*

3.7 Intellectual Property

Any copyright or other property or proprietary rights owned by the *ODRD* in any content included within the *contract documents*, whether created specifically for an individual project or otherwise made available for use on an individual project, shall remain the exclusive property of the *ODRD*.

SECTION 4. APPROVAL DOCUMENTS

4.1. Owner Responsibility

The *owner* shall furnish, in a timely manner and in accordance with the *contract documents*, the complete structural *design documents* and *specifications* that have been *released for construction*. Unless otherwise noted, *design documents* and *specifications* that are provided as part of the contract bid documents shall constitute authorization by the *owner* that the *design documents* and *specifications* are *released for construction*.

Commentary:
When the *owner* issues *design documents* and *specifications* that are *released for construction*, the *fabricator* and the *erector* rely on the fact that these are the *owner's* requirements for the project. This release is required by the *fabricator* prior to the ordering of material and the preparation and completion of the *approval documents*.

To ensure the orderly flow of material procurement, detailing, fabrication, and erection activities on phased construction projects, it is essential that designs are not continuously revised after they have been *released for construction*. In essence, once a portion of a design is *released for construction*, the essential elements of that design should be "frozen" to ensure adherence to the contract price and construction schedule. Alternatively, all parties should reach a common understanding of the effects of future changes, if any, as they affect scheduled deliveries and added costs.

A pre-detailing conference, held after the *structural steel* fabrication contract is awarded, can benefit the project. Typical attendees may include the *owner's designated representative for construction*, the *owner's designated representative for design*, the *fabricator*, the *steel detailer*, and the *erector*. Topics of the meeting should relate to the specifics of the project and might include the following:

- Contract document review and general project overview, including *clarifications* of scope of work, tolerances, layouts and sequences, and special considerations.
- Detailing and coordination needs, such as bolting, welding, and *connection* considerations, constructability considerations, OSHA requirements, coordination with other trades, and the advanced bill of materials.
- The project communication system, including distribution of contact information for relevant parties to the contract, identification of the primary and alternate contacts in the general contractor's office, and the *request for information (RFI)* system to be used on the project.
- The submittal schedule, including the method of submitting (electronic or hard copy); for hard copy, how many copies of documents are required;

connection submittals; and identification of schedule-critical areas of the project, if any.

- If digital models will be used as part of the delivery method for the *design documents*, the parties should determine and convey the levels of development, the digital model types that will be furnished, the authorized uses of such digital models, the transmission of digital models to prevent the loss or alteration of data, interoperability, and methods of review and approval. The term "levels of development" refers to the level of completeness of elements within the digital model (see the BIMFORUM *Level of Development Specification*). The term "authorized uses" refers to the permitted uses of the digital model(s) and the digital data associated with the digital model(s). Such authorized uses may include the right to (1) store and view the digital model(s) for informational purposes only; (2) rely upon, store and view the digital model(s) to carry out the work on the project; (3) reproduce and distribute the digital model(s) for informational purposes only; (4) rely upon, reproduce and distribute the digital model(s) to carry out the work; (5) incorporate additional digital data into the digital model(s) without modifying the data received to carry out the work on the project; (6) modify the digital model(s) as required to carry out the work on the project; (7) produce the digital model(s) in an archival format for the *owner* to use as a reference for as-built construction data or for the operation of the project after completion; or (8) other authorized uses specified in the *contract documents*.
- Review of quality and inspection requirements, including the approvals process for corrective work.

Record of the meeting should be written and distributed to all parties. Subsequent meetings to discuss progress and issues that arise during construction also can be helpful, particularly when they are held on a regular schedule.

4.2. Fabricator Responsibility

4.2.1 Except as provided in Section 4.5, the *fabricator* shall produce the *approval documents* for the fabrication and erection of the *structural steel* and is responsible for the following:

(a) The transfer of information from the *contract documents* into accurate and complete *approval documents*

(b) The development of accurate, detailed dimensional information to provide for the fit-up of parts in the field

(c) Information as required in ANSI/AISC 360 Section M1 and ANSI/AISC 341 Section I1

(d) Identification of *architecturally exposed structural steel* members by category in accordance with Section 10
(e) Document special conditions or other considerations required by the design concept in accordance with Section 7.10.1(b)

Commentary:
In addition to the information required in this section, *approval documents* typically include the following:

(1) Material designation and grades of the structural steel shapes and plates to be fabricated, including special CVN requirements, if any.
(2) Details of cuts, *connections*, holes, weld access holes, slots, openings, and *camber*.
(3) All dimensions, *work points* and working lines.
(4) Welds per AWS A2.4, showing size, length, and type of each weld.
(5) Bill of materials including all parts required for fabrication of the shipping piece including quantity, mark, description, length, and material grades.
(6) Type, size, length, and material grade of bolts, distinguishing between shop and field bolts.
(7) Material designation, type, size, and length of *anchor rods.*
(8) *Embedment drawings*, including details for installation of *anchor rods* and other embedments to be installed by others.
(9) Identification of required cleaning, surface preparation and shop painting.
(11) Requirements for field welded and bolted connections

Commentary:
The *fabricator* may use the services of independent *steel detailers* to produce *approval documents* and to perform other support services, such as producing advanced bills of material and bolt summaries.

As the *fabricator* develops the detailed dimensional information for production of the *approval documents*, there may be discrepancies, missing information, or conflicts discovered in the *contract documents*. See Section 3.4.

4.2.2. Any copyright or other property or proprietary rights owned by the *fabricator* in any content included within the *approval documents*, whether created specifically for an individual project or otherwise made available for use on an individual project, shall remain the exclusive property of the *fabricator*.

4.2.3. When the *approval documents* are *shop* and *erection drawings*, each *shop* and *erection drawing* shall be identified by the same drawing number throughout the duration of the project and shall be identified by *revision* number and date, with each specific *revision* clearly identified. When the *approval documents* are *fabrication* and *erection models*, each submittal shall be uniquely identified.

When the *fabricator* submits a request to change *connection* details that are described in the *contract documents*, the *fabricator* shall notify the *owner's designated representatives for design* (*ODRD*) and *construction* (*ODRC*) in writing in advance of the submission of the *approval documents*. The *owner's designated representative for design* shall review and approve or reject the request in a timely manner.

When requested to do so by the *ODRD*, the *fabricator* shall provide to the *ODRD* and the *ODRC* its schedule for the submittal of *approval documents* to facilitate the timely flow of information between all parties.

Commentary:
When the *fabricator* intends to make a submission of alternative *connection* details to those shown in the *contract documents*, the *fabricator* is obligated to notify the *ODRD* and the *ODRC* in advance. This will allow the parties involved to plan for the increased effort that may be required to review the alternative *connection* details. In addition, the *owner* will be able to evaluate the potential for cost savings and schedule improvements against the additional design cost for review of the alternative *connection* details by the *ODRD*. This evaluation by the *owner* may result in the rejection of the alternative *connection* details or acceptance of the submission for review based upon cost savings, schedule improvements, or job efficiencies.

The *ODRD* may request the *fabricator's* schedule for the submittal of the *approval documents*. This process is intended to allow the parties to plan for the staffing demands of the submission schedule. The *contract documents* may address this issue in more detail. In the absence of the requirement to provide this schedule, none need be provided.

When the *fabricator* provides a schedule for the submission of the *approval documents*, the provided schedule may be affected by *revisions* and the response time to requests for missing information or the resolution of discrepancies.

4.3. Use of Digital Files or Copies of the Design Documents

The *fabricator* shall neither use nor reproduce any part of the *design documents* as part of the *approval documents* without the written permission of the *ODRD*. When digital files or copies of the *design documents* are made available for the *fabricator's* use as part of the *approval documents*, the *fabricator* shall accept this information under the following conditions:

(a) All information contained in the digital files or copies of the *design documents* shall be considered instruments of service of the *ODRD* and shall not be used for other projects, additions to the project, or the completion of the project by others. Digital files or copies of the *design documents* shall remain the property of the *ODRD* and in no case shall the

transfer of these copies of the *design documents* be considered a sale or unrestricted license.

(b) In the event of a conflict, the *contract documents* shall govern.

(c) When a *design model* is made available for use by the *fabricator*, the *ODRC* shall designate whether the *design model* and/or other documents are to be considered the *contract documents.* See Section 1.4.

(d) Any party or entity that creates a copy of the *design model* does so at their own risk.

(e) The use of digital files or copies of the *design documents* shall not in any way obviate the *fabricator's* responsibility for proper checking and coordination of dimensions, details, member sizes and fit-up, and quantities of materials as required to facilitate the preparation of *approval documents* that are complete and accurate as required in Section 4.2.

(f) If digital files or copies of *design drawings* are used by the *fabricator,* the *fabricator* shall remove information that is not required for the fabrication or erection of the *structural steel* from the digital files or copies of the *design drawings*.

Commentary:

Copies of the *design documents* often are readily available to the *fabricator*. As a result, the *ODRD* may have reduced control over the unauthorized use of the *design documents*. There are many copyright and other legal issues to be considered.

The *ODRD* may choose to make copies of the *design documents* available to the *fabricator,* and may charge a service or licensing fee for this convenience. In doing so, a carefully negotiated agreement should be established to set out the specific responsibilities of both parties in view of the liabilities involved for both parties. For sample contracts, see Consensus Docs 301 BIM Addendum, AIA Document E202 Building Information Modeling Protocol Exhibit, AIA Document E203 Building Information Modeling and Digital Data Exhibit, AIA Document G201 Project Digital Data Protocol Form, and AIA Document G202 Project Building Information Modeling Protocol Form.

Once the *design model* has been modified by any entity other than the *owner's designated representative for design,* the resulting model is considered a copy of the *design model* and is no longer part of the *contract documents*.

The copies of the *design documents* are provided to the *fabricator* for convenience only. The information therein should be adapted for use only in reference to the placement of *structural steel* members during erection. The *fabricator* should treat this information as if it were fully produced by the *fabricator* and undertake the same level of checking and quality assurance. Amendments or *revisions* to the *contract documents* will require the *fabricator* to update this reference material.

When copies of the *design drawings* are provided to the *fabricator*, they often contain other information, such as architectural backgrounds or references

to other *contract documents*. This additional material should be removed when producing the *approval documents* to avoid the potential for confusion.

Just like the transmission of the *design documents* created by the *owner's designated representative for design* does not convey ownership rights in the *design documents*, the transmission of the *approval documents* created by the *fabricator* does not convey ownership rights in the *approval documents*.

4.4. Approval

The *approval documents* shall be submitted to the *ODRD* and the *ODRC* for review and approval. The *approval documents* shall be returned to the *fabricator* within 14 calendar days.

Final *substantiating connection information* shall also be submitted with the *approval documents* when Option 3 is designated, and as required in the *contract documents* when Option 2 is designated. The *ODRD* is the final authority in the event of a disagreement between parties regarding the design of *connections* to be incorporated into the overall *structural steel* frame. The *fabricator* and licensed *engineer* in responsible charge of *connection* design are entitled to rely upon the *connection* design criteria provided in accordance with Section 3.2. *Revisions* to these criteria shall be addressed in accordance with Sections 9.3 and 9.4.

Approved *approval documents* shall be individually annotated by the *ODRD* and the *ODRC* as either approved or approved subject to corrections noted. When so required, the *fabricator* shall subsequently make the corrections noted and furnish corrected *fabrication* and *erection documents* to the *ODRD* and the *ODRC*.

Commentary:

As used in *this Code*, the 14-day allotment for the return of *approval documents* is intended to represent the *fabricator's* portal-to-portal time. The intent in *this Code* is that, in the absence of information to the contrary in the *contract documents*, 14 days may be assumed for the purposes of bidding, contracting, and scheduling. When additional time is desired, such as when *substantiating connection information* is part of the submittals, the modified allotment should be specified in the *contract documents*. A submittal schedule is commonly used to facilitate the approval process.

If the *approval documents* are approved subject to corrections noted, the *ODRD* may or may not require that it be resubmitted for record purposes following correction. If the *approval documents* are not approved, *revisions* are made and the documents resubmitted until approval is achieved.

4.4.1. Approval, approval subject to corrections noted, and similar approvals of the *approval documents* shall constitute the following:

(a) Confirmation that the *fabricator* has correctly interpreted the *contract documents* in the preparation of those submittals.
(b) Confirmation that the *ODRD* has reviewed and approved the *connection* details shown in the *approval documents* submitted in accordance with Section 3.2.3.
(c) Release by the *ODRD* and the *ODRC* for the *fabricator* to begin fabrication using the approved submittals.

Such approval shall not relieve the *fabricator* of the responsibility for either the accuracy of the detailed dimensions in the *approval documents* or the fit-up of parts that are to be assembled in the field.

The *fabricator* shall determine the fabrication schedule that is necessary to meet the requirements of the contract.

Commentary:
When considering the current language in this Section, the Committee sought language that would parallel the practices of CASE. In CASE Document 962, CASE indicates that when the design of some element of the primary structural system is left to someone other than the *structural engineer of record*, "…such elements, including *connections* designed by others, should be reviewed by the *structural engineer of record*. He [or she] should review such designs and details, accept or reject them and be responsible for their effects on the primary structural system." Historically, *this Code* has embraced this same concept.

From the inception of *this Code*, AISC and the industry in general have recognized that only the *ODRD* has all the information necessary to evaluate the total impact of *connection* details on the overall structural design of the project. This authority traditionally has been exercised during the approval process for the *approval documents*. The *ODRD* has thus retained responsibility for the adequacy and safety of the entire structure since at least the 1927 edition of *this Code*.

4.4.2. Unless otherwise noted, any additions, deletions or *revisions* that are indicated in responses to *requests for information (RFI)* or on the approved *approval documents* shall constitute authorization by the *owner* that the additions, deletions, or *revisions* are *released for construction*. The *fabricator* and the *erector* shall promptly notify the *ODRC* when any direction or notation in responses to *RFI* or on the *approval documents* or other information will result in an additional cost or a delay. See Sections 3.6 and 9.3.

Commentary:
When the *fabricator* notifies the *ODRC* that a direction or notation in responses to *RFIs* or on the *approval documents* will result in an additional cost or a delay, it is then normally the responsibility of the *ODRC* to subsequently notify the *ODRD*.

4.5. Fabrication and Erection Documents Not Furnished by the Fabricator

When the *fabrication* and *erection documents* are not prepared by the *fabricator*, but are furnished by others, they shall be reviewed and approved by the *ODRD* and *ODRC* and final *fabrication* and *erection documents* shall be delivered to the *fabricator* in a timely manner. The *fabricator* shall not be responsible for the completeness, coordination, or accuracy of *fabrication* and *erection documents* so furnished, nor for the fit-up of the members that are fabricated in accordance with the documents provided.

Commentary:
Preparation of *fabrication* and *erection documents* by parties other than the *fabricator* may carry risks for the project team and should only be undertaken after careful consideration of these risks.

The preparation of the *fabrication* and *erection documents* is very specific to the needs of the *fabricator* performing the work, and an integral part of the constructability and coordination assurance of the project.

If a party other than the *fabricator* prepares any portion of the *fabrication* and *erection documents*, the *contract documents* should be very clear as to the responsibilities of all parties and management of this process, including the manner in which the following issues will be addressed:

- Review and approval of the *fabrication* and *erection documents* by the *ODRD*.
- Standards, format and contents of the *fabrication* and *erection documents*, or representative documents that will be part of the *contract documents*, for the mill order, field bolts, and numerical control files for fabrication.
- Provisions for proper risk management (errors and omissions or product liability, as applicable).
- Licensing of proprietary products and technology, and any associated fees.
- Incorporation of normal "pre-detailing" sequencing, erection aids, other OSHA Sub Part R requirements, or other local or regional safety requirements.
- Specific shop standards including preferred marking system of members, standard material sizes, and field considerations such as erection issues related to site access and erection clearances.
- Timing and content of information necessary for material to be sourced, ordered, delivered, stored, fabricated, and shipped to accommodate the construction schedule.
- Schedule updates for documents and tracking of impact to overall project schedule and contract, as these dates are impacted.

- *Revision* and control of *fabrication* and *erection documents* in order to maintain the integrity of all parts of the *fabrication* and erection process.
- Late released items that impact such items as, but not limited to, fabrication resource allocation, delivery dates and erection sequences, particularly if the late released items are on the project's critical path or delay the release of critical path items. Late released items include items not completed due to lack of design information, items requiring additional information from the designer, or items affected by others, such as owner's design changes or modifications to the construction sequence by the *ODRC*.
- Fabrication phase support, including issues that arise on night shift and weekends.
- Protocol for handling delays in the field, including responsibility for standby costs of labor or equipment.
- Coordination of joist, deck, and other manufactured items, including coordination and addressing of requests for information.
- Resolution of field issues and construction phase requests for information.

4.6. The RFI Process

When *requests for information* (*RFIs*) are issued, the process shall include the maintenance of a written record of inquiries and responses related to interpretation and implementation of the *contract documents*, including the *clarifications* and *revisions* to the *contract documents* that result, if any. *RFIs* shall not be used for the incremental *release for construction* of the *design documents*. When *RFIs* involve discrepancies or *revisions*, see Sections 3.4, 3.6, and 4.4.2.

When a *design model* is used as the *design documents*, the changes and *clarifications* made in response to *RFIs* shall be incorporated into the *design model*.

Commentary:

The *RFI* process is most commonly used during the detailing process, but can also be used to forward inquiries by the *erector* or to inform the *ODRD* in the event of a *fabricator* or *erector* error and to develop corrective measures to resolve such errors.

The *RFI* process is intended to provide a written record of inquiries and associated responses but not to replace all verbal communication between the parties on the project. *RFIs* should be prepared and responded to in a timely fashion so as not to delay the work of the *steel detailer*, *fabricator,* and *erector*. Discussion of the *RFI* issues and possible solutions between the *fabricator*, *erector*, and *ODRD* and the *ODRC* often can facilitate timely and practical resolution. Unlike submittals in Section 4.4, *RFI* response time can vary depending on the urgency of the issue, the amount of work required by the

ODRD and the *ODRC* to develop a complete response, and other circumstances, such as building official approval.

RFIs should be prepared in a standardized format, including *RFI* number and date, identity of the author, reference to a specific location(s) in the *design documents* or *specification* section, the needed response date, a description of a suggested solution (graphic depictions are recommended for more complex issues), and an indication of possible schedule and cost impacts. *RFIs* should be limited to one question each (unless multiple questions are interrelated to the same issue) to facilitate the resolution and minimize response time. Questions and proposed solutions presented in *RFIs* should be clear and complete. *RFI* responses should be equally clear and complete in the depictions of the solutions, and signed and dated by the responding party.

Unless otherwise noted, the *fabricator* and *erector* can assume that a response to an *RFI* constitutes a *release for construction*. However, if the response will result in an increase in cost or a delay in schedule, Section 4.4.2 requires that the *fabricator* or *erector* promptly inform the *ODRD* and the *ODRC*.

4.7 Erection Documents

The *erection documents* shall be provided to the *erector* in a timely manner to allow the *erector* to properly plan and perform the work.

Commentary:
For planning purposes, this may include release of preliminary *erection documents*, if requested by the *erector*.

SECTION 5. MATERIALS

5.1. Mill Materials

Unless otherwise noted in the *contract documents*, the *fabricator* is permitted to order the materials that are necessary for fabrication when the *fabricator* receives *contract documents* that have been *released for construction*.

Commentary:
The *fabricator* may purchase materials in stock lengths, exact lengths, or multiples of exact lengths to suit the dimensions shown in the structural *design documents*. Such purchases will normally be job-specific in nature and may not be suitable for use on other projects or returned for full credit if subsequent design changes make these materials unsuitable for their originally intended use. The *fabricator* should be paid for these materials upon delivery from the mill, subject to appropriate additional payment or credit if subsequent unanticipated modification or reorder is required. Purchasing materials to exact lengths is not considered fabrication.

5.1.1. Unless otherwise specified by means of special testing requirements in the *contract documents*, mill testing shall be limited to those tests that are required for the material in the ASTM specifications indicated in the *contract documents*. Materials shall be marked by the supplier as specified in applicable ASTM standard specifications prior to delivery to the *fabricator's* shop or other point of use. Such material not so marked by the supplier, shall not be used until

(a) Its identification is established by means of testing in accordance with the applicable ASTM specifications
(b) A *fabricator's* identification mark, as described in Section 6.1 has been applied

5.1.2. When *mill material* does not satisfy applicable ASTM tolerances for *camber*, profile, flatness, or sweep, the *fabricator* is permitted to perform corrective procedures, including the use of controlled heating and mechanical straightening, subject to the limitations in ANSI/AISC 360.

Commentary:
Dimensional tolerances for rolled *mill material* are set forth in ASTM A6/A6M. Likewise, dimensional tolerances for HSS and pipe material are set forth in the applicable ASTM standard specifications. The designer, the *fabricator*, the *steel detailer*, and the *erector* should expect and recognize normal variations in the cross-sectional geometry of standard structural shapes (for example, see Figure C-5.1). Such tolerances are mandatory because roll wear—thermal distortions of the hot cross section immediately after leaving the forming rolls and differential

cooling distortions that take place on the cooling beds—are all unavoidable. Geometric perfection of the cross section is not necessary for either structural or architectural reasons if the tolerances are recognized and provided for.

ASTM standard specifications also stipulate tolerances for straightness that are adequate for typical construction. However, these characteristics may be controlled or corrected to closer tolerances during the fabrication process when the added cost is justified by the special requirements for an atypical project.

5.1.3. When variations that exceed ASTM A6/A6M tolerances are discovered or occur after the receipt of *mill material*, the *fabricator* shall, at the *fabricator's* option, be permitted to perform the ASTM A6/A6M corrective procedures for mill reconditioning of the surface of *structural steel* shapes and plates.

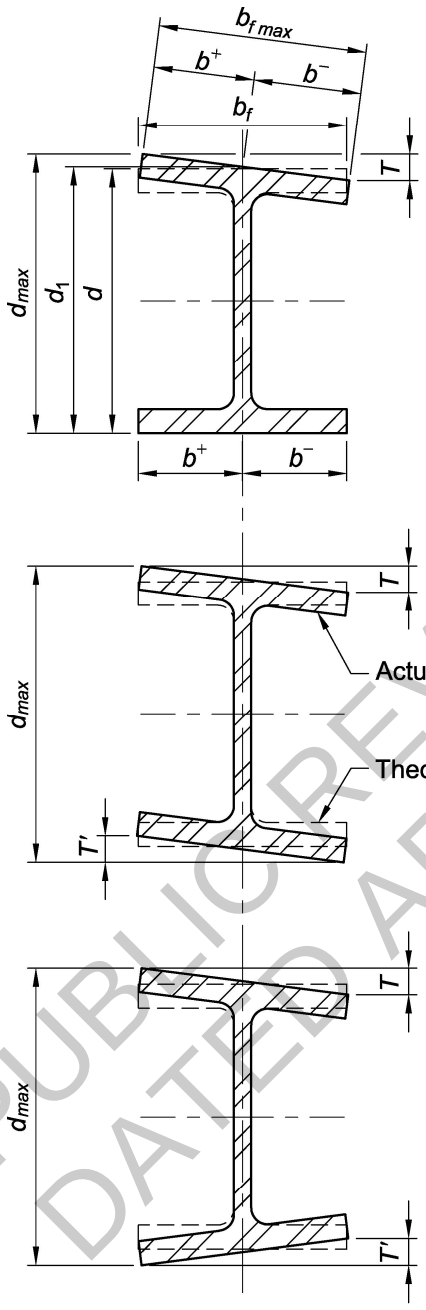
5.1.4. When special tolerances that are more restrictive than those in the applicable ASTM standard specifications are required for *mill materials*, such special tolerances shall be specified in the *contract documents*. The *fabricator* shall, at the *fabricator's* option, be permitted to order material to the applicable ASTM standard specifications tolerances and subsequently perform the corrective procedures described in Sections 5.1.2 and 5.1.3.

5.2. Stock Materials

5.2.1. If used for structural purposes, materials that are taken from stock by the *fabricator* shall be of a quality that is at least equal to that required in the ASTM specifications indicated in the *contract documents*.

5.2.2. Material test reports shall be accepted as sufficient record of the quality of materials taken from stock by the *fabricator*. The *fabricator* shall review and retain the material test reports that cover such stock materials. However, the *fabricator* need not maintain records that identify individual pieces of stock material against individual material test reports, provided the *fabricator* purchases stock materials that meet the requirements for material grade and quality in the applicable ASTM specifications.

5.2.3. Stock materials that are purchased under no particular specification, under a specification that is less rigorous than the applicable ASTM specifications, or without material test reports or other recognized test reports shall not be used without the approval of the *owner's designated representative for design*.



U.S. customary units:

Flange-tilt tolerances:
$T + T'$ = ¼ in. for $d \le 12$ in.
= 5⁄16 in. for $d > 12$ in.

Actual depth with tolerances:
d_1 = d plus or minus ⅛ in. (typ.)
d_{max} = $d + T + T'$

Actual flange width with tolerances:
b^+ = $b_f/2$ plus or minus 3⁄16 in.
b^- = $b_f/2$ minus or plus 3⁄16 in.
b_{max} = b_f plus ¼ in. or minus 3⁄16 in.

Metric units:

Flange-tilt tolerances:
$T + T'$ = 6 mm for $d \le 300$ mm
= 8 mm for $d > 300$ mm

Actual depth with tolerances:
d_1 = d plus or minus 3 mm
d_{max} = $d + T + T'$

Actual flange width with tolerances:
b^+ = $b_f/2$ plus or minus 5 mm
b^- = $b_f/2$ minus or plus 5 mm
b_{max} = b_f plus 6 mm or minus 5 mm

Fig. C-5.1. Mill tolerances on the cross section of a W-shape.

SECTION 6. SHOP FABRICATION AND DELIVERY

6.1. Identification of Material

6.1.1. The *fabricator* shall be able to demonstrate by written procedure and actual practice a method of material identification, visible up to the point of assembling members as follows:

(a) For shop-standard material, identification capability shall include shape designation. Representative material test reports shall be furnished by the *fabricator* if requested to do so by the *owner's designated representative for design* (*ODRD*), either in the *contract documents* or in separate written instructions given to the *fabricator* prior to ordering *mill materials*.

(b) For material of grade other than shop-standard material, identification capability shall include shape designation and material grade. Representative material test reports shall be furnished by the *fabricator* if requested to do so by the *ODRD*, either in the *contract documents* or in separate written instructions given to the *fabricator* prior to ordering *mill materials*.

(c) For material ordered in accordance with an ASTM supplement or other special material requirements in the *contract documents*, identification capability shall include shape designation, material grade, and heat number. The corresponding material test reports shall be furnished by the *fabricator* if requested to do so by the *ODRD*, either in the *contract documents* or in separate written instructions given to the *fabricator* prior to ordering *mill materials*.

Unless an alternative system is established in the *fabricator's* written procedures, shop-standard material shall be as follows:

Material	**Shop-Standard Material Grade**
W and WT	ASTM A992/A992M
M, S, MT, and ST	ASTM A572/A572M Grade 50
HP	ASTM A572/A572M Grade 50
L	ASTM A572/A572M Grade 50
C and MC	ASTM A992/A992M
HSS	ASTM A500/A500M Grade C
Steel Pipe	ASTM A53/A53M Grade B
Plates and Bars	ASTM A572/A572M Grade 50

Commentary:
The requirements in Section 6.1.1(a) will suffice for most projects. When material is of a strength level that differs from the shop-standard grade, the

requirements in Section 6.1.1(b) apply. When special material requirements apply, such as ASTM A6/A6M Supplement S5 or S30 for Charpy V-notch impact testing or ASTM A6/A6M Supplement S8 for ultrasonic testing, the requirements in Section 6.1.1(c) are applicable.

6.1.2. During fabrication, up to the point of assembling members, each piece of material that is ordered to special material requirements shall carry a *fabricator's* identification mark or an original supplier's identification mark. The *fabricator's* identification mark shall be in accordance with the *fabricator's* established material identification system, which shall be on record and available prior to the start of fabrication for the information of the *owner's designated representative for construction* (*ODRC*), the building code authority, and the *inspector*.

6.1.3. Members that are made of material that is ordered to special material requirements shall not be given the same assembling or erection mark as members made of other material, even if they are of identical dimensions and detail.

6.2. Preparation of Material

6.2.1. The thermal cutting of *structural steel* by hand-guided or mechanically guided means is permitted.

6.2.2. Surfaces that are specified as "finished" in the *contract documents* shall have a roughness height value measured in accordance with ASME B46.1 that is equal to or less than 500 μin. (12.5 μm). The use of any fabricating technique that produces such a finish is permitted.

Commentary:
Most cutting processes, including friction sawing and cold sawing, and milling processes meet a surface roughness limitation of 500 μin. (12.5 μm) per ASME B46.1.

6.3. Fitting and Fastening

6.3.1. Projecting elements of *connection* materials need not be straightened in the connecting plane, subject to the limitations in ANSI/AISC 360.

6.3.2. Backing and runoff tabs shall be used in accordance with AWS D1.1/D1.1M as required to produce sound welds. The *fabricator* or *erector* need not remove backing or runoff tabs unless such removal is specified in the *contract documents*. When the removal of backing is specified in the *contract documents*, such removal shall meet the requirements in AWS D1.1/D1.1M. When the

removal of runoff tabs is specified in the *contract documents*, hand flame-cutting close to the edge of the finished member with no further finishing is permitted, unless other finishing is specified in the *contract documents*.

Commentary:
In most cases, the treatment of backing and runoff tabs is left to the discretion of the *ODRD*. In some cases, treatment beyond the basic cases described in this section may be required. As one example, special treatment is required for backing and runoff tabs in beam-to-column moment *connections* when the requirements in ANSI/AISC 341 must be met. In all cases, the *ODRD* should specify the required treatments in the *contract documents*.

6.3.3. Unless otherwise noted in the *fabrication documents*, high-strength bolts for shop-attached *connection* material shall be installed in the shop in accordance with the requirements in ANSI/AISC 360.

6.4. Shop Cleaning and Painting (see also Section 3.1)

Structural steel that does not require shop paint shall be cleaned of oil and grease with solvent cleaners, and of dirt and other foreign material, by sweeping with a fiber brush or other suitable means. For *structural steel* that is required to be shop painted, the requirements in Sections 6.4.1 through 6.4.4 shall apply.

Commentary:
Extended exposure of unpainted *structural steel* that has been cleaned for the subsequent application of fire protection materials can be detrimental to the fabricated product. Most levels of cleaning require the removal of all loose mill scale but permit some amount of tightly adhering mill scale. When a piece of *structural steel* that has been cleaned to an acceptable level is left exposed to a normal environment, moisture can penetrate behind the scale, and some "lifting" of the scale by the oxidation process is to be expected. Cleanup of "lifted" mill scale is not the responsibility of the *fabricator*, but is to be assigned by contract requirement to an appropriate contractor.

Section 6.4.3 of *this Code* is not applicable to weathering steel, for which special cleaning *specifications* are always required in the *contract documents*.

6.4.1. Unless otherwise specified in the *contract documents*, the *fabricator* shall, as a minimum, hand clean the *structural steel* of loose rust, loose mill scale, dirt, and other foreign matter prior to painting, by means of wire brushing or by other methods elected by the *fabricator*, to meet the requirements of SSPC-SP2. If the *fabricator's* workmanship on surface preparation is to be inspected by the *inspector*, such inspection shall be performed in a timely manner prior to the application of the shop coat.

Commentary:

The selection of a paint system is a design decision involving many factors including the following:

(a) The *owner's* preference
(b) The service life of the structure
(c) The severity of environmental exposure
(d) The cost of both initial application and future renewals
(e) The compatibility of the various components that comprise the paint system (surface preparation, shop coat, and subsequent coats)

Because the inspection of shop painting must be concerned with workmanship at each stage of the operation, the *fabricator* provides notice of the schedule of operations and affords the *inspector* access to the work site. Inspection must then be coordinated with that schedule to avoid delay of the scheduled operations.

Acceptance of the prepared surface is made prior to the application of the required shop coat(s) because the degree of surface preparation cannot be readily verified after painting. Time delay between surface preparation and the application of the required shop coat(s) can result in unacceptable deterioration of a properly prepared surface, necessitating a repetition of surface preparation. This is especially true with blast-cleaned surfaces. The required shop coat(s) in any paint system is designed to maximize the wetting and adherence characteristics of the paint, usually at the expense of its weathering capabilities. Deterioration of the required shop coat(s) normally begins immediately after exposure to the elements and worsens as the duration of exposure is extended. Consequently, extended exposure of the required shop coat(s) will likely lead to its deterioration and may necessitate repair, possibly including the repetition of surface preparation and shop coat application in limited areas. With the introduction of high-performance paint systems, avoiding delay in the application of the shop coat has become more critical. High-performance paint systems generally require a greater degree of surface preparation, as well as early application of weathering protection for the required shop coat(s).

Because the *fabricator* does not control the selection of the paint system, the compatibility of the various components of the total paint system, or the length of exposure of the required shop coat(s), the *fabricator* cannot guarantee the performance of the required shop coat(s) or any other part of the system. Instead, the *fabricator* is responsible only for accomplishing the specified surface preparation and for applying the required shop coat(s) in accordance with the *contract documents*.

This Section stipulates that the *structural steel* is to be cleaned to meet the requirements in SSPC-SP2. This stipulation is not intended to represent an exclusive cleaning level, but rather the level of surface preparation that will be

furnished unless otherwise specified in the *contract documents* if the *structural steel* is to be painted.

6.4.2. Unless otherwise specified in the *contract documents*, paint shall be applied by brushing, spraying, rolling, flow coating, dipping, or other suitable means, at the election of the *fabricator*. When the term "shop coat," "shop paint," or other equivalent term is used with no paint system specified, the *fabricator's* standard shop paint shall be applied to a minimum dry-film thickness of one mil (0.025 mm). Unless specifically provided for in the *contract documents*, the properties of the optional shop coat are at the discretion of the *fabricator*.

6.4.3. Touch-up of abrasions caused by shipping and handling after painting shall be the responsibility of the contractor that performs touch-up in the field or field painting.

Commentary:
Touch-up in the field and field painting are not normally part of the *fabricator's* or the *erector's* contract.

6.4.4. The *fabricator* shall not be responsible for deterioration of the shop-applied paint when the paint is exposed to atmospheric conditions or corrosive conditions that are more severe than the intended use of the paint; or when painted members are stored for unanticipated durations due to project delays not caused by the *fabricator*. Handling damage or damage during transportation is not the responsibility of the *fabricator* unless the painted material is under the direct control of the *fabricator* or a subcontractor of the *fabricator*.

Commentary:
Paint systems are designed by the manufacturer to perform for a specific amount of time in specific environments. The appropriateness of a paint system and its required application is provided in the paint manufacturer's technical data sheet. If the painted material is used or stored in conditions that are beyond the paint system's design intent and the *fabricator* can show that they followed the directions of the paint data sheet, the fabricator is not responsible if the system fails to perform.

It is common practice that the *fabricator* temporarily stores the painted material at their plant or a third-party coating subcontractor until it is loaded for shipment. Once the painted material leaves the direct control of the *fabricator* or a subcontractor of the *fabricator*, the *fabricator* cannot be held responsible for damage.

6.5. Marking and Shipping of Materials

6.5.1. Unless otherwise specified in the *contract documents*, erection marks shall be applied to the *structural steel* members by painting or other suitable means.

6.5.2 Bolt assemblies and loose bolts, nuts, and washers shall be shipped in separate closed containers according to length and diameter, as applicable. Pins and other small parts and packages of bolts, nuts, and washers shall be shipped in boxes, crates, kegs, or barrels. A list and description of the material shall appear on the outside of each closed container.

Commentary:
In most cases, bolts, nuts, and other components in a fastener assembly can be shipped loose in separate containers. However, there are exceptions:

- ASTM F3125/F3125M Grades F1852 and F2280 twist-off-type tension-control bolt assemblies require assembly and shipment in containers according to grade, length, and diameter.
- Galvanized ASTM F3125/F3125M Grade A325 and A325M bolts and their corresponding ASTM A563 or A563M nuts require shipment in the same container according to length and diameter.

See these ASTM standards for the applicable requirements and the RCSC Specification for further explanation.

6.6. Delivery of Materials

6.6.1. Fabricated *structural steel* shall be delivered in a sequence that will permit efficient and economical fabrication and erection, and that is consistent with requirements in the *contract documents*. If the *owner* or *ODRC* wishes to prescribe or control the sequence of delivery of materials, that entity shall specify the required sequence in the *contract documents*. If the *ODRC* contracts separately for delivery and for erection, the *ODRC* shall coordinate planning between contractors.

6.6.2. *Anchor rods*, washers, nuts, and other anchorage or grillage materials that are to be built into concrete or masonry shall be shipped so that they will be available when needed. The *ODRC* shall allow the *fabricator* sufficient time to fabricate and ship such materials before they are needed.

6.6.3. If any shortage is claimed relative to the quantities of materials that are shown in the shipping statements, the *ODRC* or the *erector* shall promptly notify the *fabricator* so that the claim can be investigated.

Commentary:

The quantities of material that are shown in the shipping statement are customarily accepted as correct by the *ODRC*, the *fabricator,* and the *erector*.

6.6.4. Unless otherwise specified in the *contract documents*, and subject to the approved *approval documents*, the *fabricator* shall limit the number of field splices to that consistent with minimum project cost.

Commentary:
This section recognizes that the size and weight of *structural steel* assemblies may be limited by shop capabilities, the permissible weight, and clearance dimensions of available transportation or jobsite conditions.

6.6.5. If material arrives at its destination in damaged condition, the receiving entity shall promptly notify the *fabricator* and carrier prior to unloading the material or promptly upon discovery prior to erection.

SECTION 7. ERECTION

7.1. Method of Erection

Fabricated *structural steel* shall be erected using methods and a sequence that will permit efficient and economical performance of erection, and that is consistent with the requirements in the *contract documents*. If the *owner* or *owner's designated representative for construction* (*ODRC*) wishes to prescribe or control the method or sequence of erection, or specifies that certain members cannot be erected in their normal sequence, that entity shall specify the required method and sequence in the *contract documents*. If the *ODRC* contracts separately for fabrication services and for erection services, the *ODRC* shall coordinate planning between contractors.

Commentary:
Design modifications, erection aids, or both are sometimes requested by the *erector* to allow or facilitate the erection of the *structural steel* frame. When this is the case, the *erector* should notify the *fabricator* prior to the preparation of the *approval documents* so that the *fabricator* may refer the *erector's* request to the *owner's designated representatives for design* and *construction* for resolution.

7.2. Jobsite Conditions

The *ODRC* shall provide and maintain the following for the *fabricator* and the *erector*:

(a) Adequate access roads into and through the jobsite for the safe delivery and movement of the material to be erected and of derricks, cranes, trucks, and other necessary equipment under their own power
(b) A firm, properly graded, drained, convenient, and adequate space at the jobsite for the operation of the *erector's* equipment, free from overhead obstructions, such as power lines, telephone lines, or similar conditions
(c) Adequate storage space, when the structure does not occupy the full available jobsite, to enable the *fabricator* and the *erector* to operate at maximum practical speed

Otherwise, the *ODRC* shall inform the *fabricator* and the *erector* of the actual jobsite conditions and any special delivery requirements prior to bidding.

7.3. Foundations, Piers, and Abutments

The accurate location, strength, and suitability of, and access to, all foundations, piers, and abutments shall be the responsibility of the *ODRC*.

7.4. Control Lines and Benchmarks

The *ODRC* shall be responsible for the accurate location of *control lines* and *benchmarks* at the jobsite and shall furnish the *erector* with a plan that contains all such information. The *ODRC* shall establish *control lines* and reference elevations at each level for the *erector's* use in the positioning of *adjustable items* (see Section 11.3.1.3), if any.

7.5. Installation of Anchor Rods, Foundation Bolts, and Other Embedded Items

7.5.1. *Anchor rods*, foundation bolts, and other embedded items shall be set by the *ODRC* in accordance with *embedment drawings* that have been approved by the *owner's designated representatives for design* (*ODRD*) and the *ODRC*. The variation in location of these items from the dimensions shown in the approved *embedment drawings* shall be as follows:

(a) The vertical variation in location from the specified top of *anchor rod* location shall be a maximum of plus or minus 1/2 in. (13 mm).
(b) The horizontal variation in location from the specified position of each *anchor rod* centerline at any location along its projection above the concrete shall be equal to or less than the dimensions given for the *anchor rod* diameters listed as follows:

Anchor rod diameter, in. (mm)	**Horizontal Variation, in. (mm)**
3/4 and 7/8 (19 and 22)	1/4 (6)
1, 1-1/4, 1-1/2 (25, 31, 38)	3/8 (10)
1-3/4, 2, 2-1/2 (44, 50, 63)	1/2 (13)

Commentary:
The tolerances established in this Section have been selected for compatibility with the holes sizes that are recommended for base plates in the AISC *Steel Construction Manual*. If special conditions require more restrictive tolerances, such as for smaller holes, the required tolerances should be stated in the *contract documents*. When the *anchor rods* are set in sleeves, the adjustment provided may be used to satisfy the required *anchor-rod* setting tolerances.

7.5.2. Unless otherwise specified in the *contract documents*, *anchor rods* shall be set with their longitudinal axis perpendicular to the theoretical bearing surface.

7.5.3. Embedded items and *connection* materials that are part of the work of other trades, but that will receive *structural steel*, shall be located and set by the *ODRC* in compliance with trade tolerances and in accordance with an *embedment drawing* approved by the *ODRD* and *ODRC* and that conforms with Section 3.2.3(h).

Commentary:
This provision relates to the relatively common condition in which concrete work, such as cast-in-place, precast, or tilt up panels receive *structural steel* by means of "embedded items and connection materials." Since steel frame erection usually follows concrete work with embedded items, provisions for adjustment at these conditions should be made in the designs and details in the *construction documents* by the ODRD.

7.5.4. All work that is performed by the *ODRC* shall be completed so as not to delay or interfere with the work of the *fabricator* and the *erector*. The *ODRC* shall conduct a survey of the as-built locations of *anchor rods*, foundation bolts, and other embedded items, and shall verify that all items covered in Section 7.5 meet the corresponding tolerances. When corrective action is necessary, the *ODRC* shall obtain the guidance and approval of the *ODRD*.

Commentary:
Few *fabricators* or *erectors* have the capability to provide this survey. Under standard practice, it is the responsibility of others.

7.6. Installation of Bearing Devices

7.6.1 All leveling plates, leveling nuts, and washers, and loose base and bearing plates that can be handled without a derrick or crane are set to line and grade by the *ODRC*.

7.6.2 Loose base and bearing plates that require handling with a derrick or crane shall be set by the erector to lines and grades established by the *ODRC*. The *fabricator* shall clearly scribe loose base and bearing plates with lines or other suitable marks to facilitate proper alignment.

7.6.3 Base and bearing plates that are shop attached to shipping pieces shall be set with the shipping pieces by the *erector* to lines and grades established by the *ODRC*. See Section 11.3.

7.6.4 Promptly after the setting of all *bearing devices*, the *ODRC* shall check them for line and grade, as required in Section 7.6.4(a) and 7.6.4(b). The permissible variation in elevation relative to the specified grade for all *bearing devices* shall be a maximum of plus or minus 1/8 in. (3 mm). The final location of *bearing devices* shall be the responsibility of the *ODRC*.

(a) For base and bearing plates shop attached to shipping pieces, the variation shall be measured at the top of the base or bearing plate.

(b) For loose base and bearing plates and other leveling devices, the variation shall be measured at the top of the base or bearing plate, or devices.

Commentary:
The 1/8 in. (3 mm) tolerance on elevation of *bearing devices* relative to established grades is provided to permit some variation in setting *bearing devices*, and to account for the accuracy that is attainable with standard surveying instruments. The use of leveling plates larger than 22 in. by 22 in. (550 mm by 550 mm) is discouraged and grouting is recommended with larger sizes.

For pre-grouted leveling plates used for column base plate bearing, ANSI/AISC 360 Section M4.4 defines an allowable gap of 1/16 in. (2mm) between the pre-grouted leveling plate and the erected column base plate. However, even when a leveling plate conforms to ASTM A6/A6M flatness requirements, erection and plumbing-up activities can result in a gap exceeding the maximum allowable gap between the pre-grouted leveling plate and the erected column base plate and should be addressed.

For the purposes of erection stability, the use of leveling nuts and washers is discouraged when base plates have less than four *anchor rods*. See CFR 1926.751 and 1926.755.

7.7. Grouting

Grouting shall be the responsibility of the *ODRC*. Leveling plates and loose base and bearing plates shall be promptly grouted after they are set and checked for line and grade. Columns with attached base plates, beams with attached bearing plates, and other similar members with attached *bearing devices* that are temporarily supported on leveling nuts and washers, shims, or other similar leveling devices, shall be promptly grouted after the *structural steel* frame, or portion thereof, has been plumbed.

Commentary:
In the majority of structures, the vertical load from the column bases is transmitted to the foundations through structural grout. In general, there are three methods by which support is provided for column bases during erection:

(a) Pre-grouted leveling plates or loose base plates
(b) Shims
(c) Leveling nuts and washers on the *anchor rods* beneath the column base

Standard practice provides that loose base plates and leveling plates are to be grouted as they are set. When pre-grouted leveling plates are the selected method, see the Commentary in Section 7.6. *Bearing devices* that are set on shims or leveling nuts are grouted after plumbing, which means that the weight

of the erected *structural steel* frame is supported on the shims or washers, nuts, and *anchor rods*. The *erector* must take care to ensure that the load that is transmitted in this temporary condition does not exceed the strength of the shims or washers, nuts, and *anchor rods*. These considerations are presented in greater detail in AISC Design Guide 1, *Base Plate and Anchor Rod Design*, and AISC Design Guide 10, *Erection Bracing of Low-Rise Structural Steel Frames*.

7.8. Field Connection Material

7.8.1. The *fabricator* shall provide field *connection* details that are consistent with the requirements in the *contract documents* and that will, in the *fabricator's* opinion, result in economical fabrication and erection.

7.8.2. When the *fabricator* is responsible for erecting the *structural steel*, the *fabricator* shall furnish all materials that are required for both temporary and permanent *connection* of the component parts of the *structural steel* frame.

7.8.3. When the erection of the *structural steel* is not performed by the *fabricator*, the *fabricator* shall furnish the following field *connection* material:

(a) Bolts, nuts, and washers in sufficient quantity for all *structural steel*-to-*structural steel* field *connections* that are to be permanently bolted. The *fabricator* shall include an extra 2% plus three bolts, subject to a minimum of five extra bolts of each grade, type, diameter, length, and production lot number.
(b) Shims that are shown as necessary for make-up of permanent *structural steel*-to-*structural steel* field *connections*.
(c) Steel backing and runoff tabs that are required for field welding.

7.8.4. The *erector* shall furnish all welding electrodes, fit-up bolts, and drift pins used for the erection of the *structural steel*. Non-steel backing, if used, shall be furnished by the erector.

Commentary:
See the Commentary for Section 2.2.

7.9. Loose Material

Unless otherwise specified in the *contract documents*, loose *structural steel* items that are not connected to the *structural steel* frame shall be set by the *ODRC* without assistance from the *erector*.

7.10. Temporary Support of Structural Steel Frames

7.10.1. The *ODRD* shall identify the following in the *contract documents*:

(a) The lateral force-resisting system and connecting diaphragm elements that provide for lateral strength and stability in the completed structure
(b) Any special erection conditions or other considerations that are required by the design concept, such as the use of shores, jacks, or loads that must be adjusted as erection progresses to set or maintain *camber*, position within specified tolerances, or prestress

Commentary:
The intent of Section 7.10.1 of *the Code* is to alert the *ODRC* and the *erector* of the means for lateral force resistance in the completed structure so that appropriate planning can occur for construction of the building. Examples of a description of the lateral force-resisting system as required in Section 7.10.1(a) are shown in the following.

Example 1 is an all-steel building with a composite metal deck and concrete floor system. All lateral force resistance is provided by welded moment frames in each orthogonal building direction. One suitable description of this lateral force-resisting system is as follows:

All lateral force resistance and stability of the building in the completed structure is provided by moment frames with welded beam-to-column connections framed in each orthogonal direction (see plan sheets for locations). The composite metal deck and concrete floors serve as horizontal diaphragms that distribute the lateral wind and seismic forces horizontally to the vertical moment frames. The vertical moment frames carry the applied lateral loads to the building foundation.

Example 2 is a steel-framed building with a composite metal deck and concrete floor system. All beam-to-column *connections* are simple *connections* and all lateral force resistance is provided by reinforced concrete shear walls in the building core and in the stairwells. One suitable description of this lateral force-resisting system is as follows:

All lateral force resistance and stability of the building in the completed structure is provided exclusively by cast-in-place reinforced concrete shear walls in the building core and stairwells (see plan sheets for locations). These walls provide all lateral force resistance in each orthogonal building direction. The composite metal deck and concrete floors serve as horizontal diaphragms that distribute the lateral wind and seismic forces horizontally to the concrete shear walls. The concrete shear walls carry the applied lateral loads to the building foundation.

See also Commentary Section 7.10.3.

Section 7.10.1(b) is intended to apply to special requirements inherent in the design concept that could not otherwise be known by the *erector*. Such

conditions might include designs that require the use of shores or jacks to impart a load or to obtain a specific elevation or position in a subsequent step of the erection process in a sequentially erected structure or member. These requirements would not be apparent to an *erector* and are required to be identified so the *erector* can properly bid, plan, and perform the erection.

The *erector* is responsible for installation of all members (including cantilevered members) to the specified plumbness, elevation, and alignment within the erection tolerances specified in *this Code*. The *erector* is responsible for furnishing all temporary supports and devices to maintain elevation or position within these tolerances. This work is part of the means and methods of the *erector* and the *ODRD* need not specify these methods or related equipment.

See also the preset elevation requirements for cantilevered members in Section A4 of ANSI/AISC 360.

7.10.2. The *ODRC* shall indicate to the *erector* prior to bidding, the installation schedule for non-*structural steel* elements of the lateral force-resisting system and connecting diaphragm elements identified by the *ODRD* in the *contract documents*.

Commentary:
See Commentary Section 7.10.3.

7.10.3. Based upon the information provided in accordance with Sections 7.10.1 and 7.10.2, the *erector* shall determine the need for, furnish, and install all temporary supports, such as temporary guys, cables, beams, falsework, cribbing, erection aids, or other elements required for the erection operation. If the selection or design of such temporary supports is necessary, this shall be the responsibility of the erector. These temporary supports shall be sufficient to secure and maintain the stability of the bare *structural steel* framing, or any portion thereof, against loads that are likely to be encountered during erection, including those due to wind and those that result from erection operations.

The *erector* need not consider loads during erection that result from the performance of work by, or the acts of, others, except as specifically identified by the *ODRD* or the *ODRC.* Further, the *erector* need not consider those loads that are unpredictable, such as loads due to hurricane, tornado, earthquake, explosion, or collision.

Temporary supports that are required during or after the erection of the *structural steel* frame for the support of loads caused by non-*structural steel* elements, including cladding, interior partitions, and other such elements that will induce or transmit loads to the *structural steel* frame during or after erection, shall be the responsibility of others.

Commentary:

Many *structural steel* frames have lateral force-resisting systems that are activated during the erection process. Such lateral force-resisting systems may consist of welded moment frames, braced frames, or, in some instances, columns that cantilever from fixed-base foundations. Such frames are normally braced with temporary guys that, together with the steel deck floor and roof diaphragms or other diaphragm bracing that may be included as part of the design, provide stability during the erection process. The guy cables are also commonly used to plumb the *structural steel* frame. The *erector* normally furnishes and installs the required temporary supports and bracing to secure the bare *structural steel* frame, or portion thereof, during the erection process. When *erection bracing drawings* are required in the *contract documents*, those drawings show this information. The need for and selection or design of temporary supports should be based on industry standards such as AISC Design Guide 10, *Erection Bracing of Low-Rise Structural Steel Frames*.

If the *ODRC* determines that steel decking is not installed by the *erector*, temporary diaphragm bracing may be required if a horizontal diaphragm is not available to distribute loads to the vertical and lateral force-resisting system. If the steel deck will not be available as a diaphragm during *structural steel* erection, the *ODRC* is responsible for communicating this condition to the *erector* prior to bidding. If such diaphragm bracing is required, it will be furnished and installed by the *erector*.

Sometimes structural systems that are employed by the *ODRD* rely upon other elements besides the *structural steel* frame for lateral force resistance. For instance, concrete or masonry shear walls or precast spandrels may be used to provide resistance to vertical and lateral forces in the completed structure. Because these situations may not be obvious to the contractor or the *erector*, it is required in *this Code* that the *ODRD* identify such situations in the *contract documents*. Similarly, if a structure is designed so that special erection techniques are required, such as jacking to impose certain loads or position during erection, it is required in *this Code* that such requirements be specifically identified in the *contract documents*.

In some instances, the *ODRD* may elect to show erection bracing in the structural *design documents*. When this is the case, the *ODRD* should then confirm that the bracing requirements were understood by review and approval of the *erection documents* during the submittal process.

Sometimes during construction of a building, collateral building elements, such as exterior cladding, may be required to be installed on the bare *structural steel* frame prior to completion of the lateral force-resisting system. These elements may increase the potential for lateral loads on the temporary supports. Such temporary supports may also be required to be left in place after the *structural steel* frame has been erected. Special provisions should be made by the *ODRC* for these conditions.

7.10.4. All temporary supports that are required for the erection operation and furnished and installed by the *erector* shall remain the property of the *erector* and shall not be modified, moved, or removed without the consent of the *erector*. Temporary supports provided by the *erector* shall remain in place until the portion of the *structural steel* frame that they brace is complete and the lateral force-resisting system and connecting diaphragm elements identified by the *ODRD* in accordance with Section 7.10.1 are installed. Temporary supports that are required to be left in place after the completion of *structural steel* erection shall be removed when no longer needed by the *ODRC* and returned to the *erector* in good condition.

7.11. Safety Protection

7.11.1. The *erector* shall provide floor coverings, handrails, walkways, and other safety protection for the *erector's* personnel as required by law and the applicable safety regulations. Unless otherwise specified in the *contract documents*, the *erector* is permitted to remove such safety protection from areas where the erection operations are completed.

7.11.2. When safety protection provided by the *erector* is left in an area for the use of other trades after the *structural steel* erection activity is completed, the *ODRC* shall

(a) Accept responsibility for and maintain this protection
(b) Indemnify the *fabricator* and the *erector* from damages that may be incurred from the use of this protection by other trades
(c) Ensure that this protection is adequate for use by other affected trades
(d) Ensure that this protection complies with applicable safety regulations when being used by other trades
(e) Remove this protection when it is no longer required and return it to the *erector* in the same condition as it was received

7.11.3. Safety protection for other trades that are not under the direct employment of the *erector* shall be the responsibility of the *ODRC*.

7.11.4. When permanent steel decking is used for protective flooring and is installed by the *ODRC*, all such work shall be scheduled and performed in a timely manner so as not to interfere with or delay the work of the *fabricator* or the *erector*. The sequence of installation that is used shall meet all safety regulations.

7.11.5. Unless the interaction and safety of activities of others, such as construction by others or the storage of materials that belong to others, are coordinated with the work of the *erector* by the *ODRC*, such activities are prohibited until the

erection of the *structural steel* frame, or portion thereof, is completed by the *erector* and accepted by the *ODRC*.

7.12. Accumulation of Mill and Fabrication Tolerances

The accumulation of mill tolerances and fabrication tolerances shall not cause the erection tolerances to be exceeded.

Commentary:
In editions of *this Code* previous to the 2005 edition, it was stated that "…variations are deemed to be within the limits of good practice when they do not exceed the cumulative effect of rolling tolerances, fabricating tolerances and erection tolerances." It is recognized in the current provision in this Section that accumulations of mill tolerances and fabrication tolerances generally occur between the locations at which erection tolerances are applied, and not at the same locations.

7.13 Owner's Acceptance

. Prior to placing or applying any other materials, the *ODRC* shall determine that the location of the *structural steel* is acceptable for plumbness, elevation, and alignment and is in accordance with applicable requirements of *this Code*, ANSI/AISC 360 Chapters M and N, and any project specific requirements. The *erector* shall be given either timely notice of acceptance by the *ODRC* or a listing of specific items that are to be corrected in order to obtain acceptance. Such notice shall be rendered promptly upon completion of any part of the work and prior to the start of work by other trades that may be supported, attached, or applied to the *structural steel* frame.

7.14. Correction of Errors

The correction of minor misfits by moderate amounts of reaming, grinding, welding, or cutting, and the drawing of elements into line with drift pins shall be considered to be normal erection operations. Errors that cannot be corrected using the foregoing means, or that require major changes in member or *connection* configuration, shall be promptly reported to the *ODRD*, the *ODRC*, and the *fabricator*, by the *erector*, to enable the responsible entity to either correct the error or approve the most efficient and economical method of correction to be used by others.

Commentary:
As used in this Section, the term "moderate" refers to the amount of reaming, grinding, welding, or cutting that must be done on the project as a whole, not the amount that is required at an individual location. It is not intended to address

limitations on the amount of material that is removed by reaming at an individual bolt hole, for example, which is limited by the bolt-hole size and tolerance requirements in ANSI/AISC 360 and the RCSC Specification.

7.15. Cuts, Alterations, and Holes for Other Trades

Neither the *fabricator* nor the *erector* shall cut, drill, or otherwise alter their work, nor the work of other trades, to accommodate other trades, unless such work is clearly specified in the *contract documents*. When such work is so specified, the *ODRD* and the *ODRC* shall furnish complete information as to materials, size, location, and number of alterations in a timely manner so as not to delay the preparation of the *approval documents*.

7.16. Handling and Storage

The *erector* shall take reasonable care in the proper handling and storage of the *structural steel* during erection operations to avoid the accumulation of excess dirt and foreign matter. The *erector* shall not be responsible for the removal from the *structural steel* of dust, dirt, or other foreign matter that may accumulate during erection as the result of jobsite conditions or exposure to the elements. The *erector* shall handle and store all bolts, nuts, washers, and related fastening products in accordance with the requirements of the RCSC Specification.

Commentary:

During storage, loading, transport, unloading, and erection, blemish marks caused by slings, chains, blocking, tie-downs, etc., occur in varying degrees. Abrasions caused by handling or cartage after painting are to be expected. Any shop-applied coating, no matter how carefully protected, will require touching up in the field. Touching up these blemished areas is the responsibility of the contractor performing the field touch-up or field painting.

The *erector* is responsible for the proper storage and handling of fabricated *structural steel* at the jobsite during erection. Shop-painted *structural steel* that is stored in the field pending erection should be kept free of the ground and positioned to minimize the potential for water retention. The *owner* or *ODRC* is responsible for providing suitable jobsite conditions and proper access so that the *fabricator* and the *erector* may perform their work.

Jobsite conditions are frequently muddy, sandy, dusty, or a combination thereof during the erection period. Under such conditions, it may be impossible to store and handle the *structural steel* in such a way as to completely avoid any accumulation of mud, dirt, or sand on the surface of the *structural steel*, even though the *fabricator* and the *erector* manages to proceed with their work.

Repairs of damage to painted surfaces and removal of foreign materials due to adverse jobsite conditions are outside the scope of responsibility of the

fabricator and the *erector* when reasonable attempts at proper handling and storage have been made.

7.17. Field Painting (see also Section 3.1)

Neither the *fabricator* nor the *erector* is responsible to paint field bolt heads and nuts or field welds, nor to touch up abrasions of the shop coat, nor to perform any other field painting.

7.18. Final Cleaning Up

Upon the completion of erection and before final acceptance, the *erector* shall remove all of the *erector's* falsework, rubbish, and temporary buildings.

SECTION 8. QUALITY CONTROL

8.1. General

8.1.1. The *fabricator* shall maintain a quality control program to ensure that the work is performed in accordance with the requirements in *this Code*, ANSI/AISC 360, and the *contract documents*. The *fabricator* shall have the option to use the AISC Quality Certification Program to establish and administer the quality control program.

Commentary:
The AISC Quality Certification Program confirms to the construction industry that a certified *structural steel* fabrication shop has the capability by reason of commitment, personnel, organization, experience, procedures, knowledge, and equipment to produce fabricated *structural steel* of the required quality for a given category of work. The AISC Quality Certification Program is not intended to involve inspection or judgment of product quality on individual projects; neither is it intended to guarantee the quality of specific fabricated *structural steel* products.

8.1.2. The *erector* shall maintain a quality control program to ensure that the work is performed in accordance with the requirements in *this Code*, ANSI/AISC 360, and the *contract documents*. The *erector* shall be capable of performing the erection of the *structural steel* and shall provide the equipment, personnel, and management for the scope, magnitude, and required quality of each project. The *erector* shall have the option to use the AISC Erector Certification Program to establish and administer the quality control program.

Commentary:
The AISC Erector Certification Program confirms to the construction industry that a certified *structural steel erector* has the capability by reason of commitment, personnel, organization, experience, procedures, knowledge, and equipment to erect fabricated *structural steel* to the required quality for a given category of work. The AISC Erector Certification Program is not intended to involve inspection or judgment of product quality on individual projects; neither is it intended to guarantee the quality of specific erected *structural steel* products.

8.1.3. When the *owner* requires more extensive quality control procedures or independent inspection by qualified personnel, or requires that the *fabricator* be certified under the AISC Quality Certification Program or that the *erector* be certified under the AISC Erector Certification Program, this shall be clearly stated in the *contract documents*, including a definition of the scope of such inspection.

8.2. Inspection of Mill Material

Material test reports shall constitute sufficient evidence that the mill product satisfies material order requirements. The *fabricator* shall make a visual inspection of material that is received from the mill, but need not perform any material tests unless the *owner's designated representative for design* (*ODRD*) specifies in the *contract documents* that additional testing is to be performed at the *owner's* expense.

8.3. Nondestructive Testing

When nondestructive testing is required, the process, extent, technique, and standards of acceptance shall be clearly specified in the *contract documents*.

8.4. Surface Preparation and Shop Painting Inspection

Inspection of surface preparation and shop painting shall be planned for the acceptance of each operation as the *fabricator* completes it. Inspection of the paint system, including material and thickness, shall be made promptly upon completion of the paint application. When wet-film thickness is to be inspected, it shall be measured during the application.

8.5. Independent Inspection

When inspection by personnel other than those of the *fabricator* or *erector* is specified in the *contract documents*, the requirements in Sections 8.5.1 through 8.5.6 shall be met.

8.5.1. The *fabricator* and the *erector* shall provide the *inspector* with access to all places where the work is being performed. A minimum of 24 hours notification shall be given prior to the commencement of work.

8.5.2. Inspection of shop work by the *inspector* shall be performed in the *fabricator's* shop. Such inspections shall be timely, in-sequence, and performed in such a manner as will not disrupt fabrication operations and will permit the repair of nonconforming work prior to any required painting while the material is still in-process in the fabrication shop.

8.5.3. Inspection of field work shall be promptly completed without delaying the progress or correction of the work.

8.5.4. Rejection of material or workmanship that is not in conformance with the *contract documents* is permitted at any time during the progress of the work.

However, this provision shall not relieve the *owner* or the *inspector* of the obligation for timely, in-sequence inspections.

8.5.5. The *fabricator*, *erector***,** and *ODRD* and the *owner's designated representatives for construction* (*ODRC*) shall be informed of deficiencies that are noted by the *inspector* promptly after the inspection. Copies of all reports prepared by the *inspector* shall be promptly given to the *fabricator*, *erector*, *ODRD*, and *ODRC*. The necessary corrective work shall be performed in a timely manner.

8.5.6. The *inspector* shall not suggest, direct, or approve the *fabricator* or *erector* to deviate from the *contract documents* or the approved *approval documents*, or approve such deviation, without the written approval of the *ODRD* and the *ODRC*.

SECTION 9. CONTRACTS

9.1. Contracts and Payment

9.1.1. For contracts that stipulate a lump sum price, the work that is required to be performed by the *fabricator* and the *erector* shall be completely defined in the *contract documents*.

9.1.2. For contracts that stipulate a price per pound, the scope of work that is required to be performed by the *fabricator* and the *erector*, the type of materials, the character of fabrication, and the conditions of erection shall be based upon the *contract documents*, which shall be representative of the work to be performed.

9.1.3. For contracts that stipulate a price per item, the work that is required to be performed by the *fabricator* and the *erector* shall be based upon the quantity and the character of the items that are described in the *contract documents*.

9.1.4. For contracts that stipulate unit prices for various categories of *structural steel*, the scope of work that is required to be performed by the *fabricator* and the *erector* shall be based upon the quantity, character, and complexity of the items in each category as described in the *contract documents*, and shall also be representative of the work to be performed in each category.

9.1.5. When an *allowance* for work is called for in the *contract documents* and the associated work is subsequently defined as to the quantity, complexity, and timing of that work after the contract is executed, the contract price for this work shall be adjusted by change order.

Commentary:
Allowances, if used, are not a true definition of the cost of work to be performed. By nature, an *allowance* is only an estimate and placeholder in the bid. Once the actual work is defined, the actual cost can be provided. It must be recognized that the actual cost can be higher or lower than the *allowance*. See Section 9.4.

Allowances required by the *contract documents* or proposed by the bidder should be as thoroughly defined as practicable as to the distinct nature of the work covered by the *allowance*, including whether the *allowance* is to include material, fabrication, or erection costs.

9.2. Calculation of Weights

Unless otherwise specified in the contract, for contracts stipulating a price per pound for fabricated *structural steel* that is delivered or erected, the quantities of materials for payment shall be determined by the calculation of the gross weight of materials as shown in the *fabrication documents*.

Commentary:
The standard procedure for calculation of weights that is described in *this Code* meets the need for a universally acceptable system for defining "pay weights" in contracts based upon the weight of delivered or erected materials. These procedures permit the *owner* to easily and accurately evaluate price-per-pound proposals from potential suppliers and enables all parties to a contract to have a clear and common understanding of the basis for payment.

The procedure in *this Code* affords a simple, readily understood method of calculation that will produce pay weights that are consistent throughout the industry and that may be easily verified by the *owner*. While this procedure does not produce actual weights, it can be used by purchasers and suppliers to define a widely accepted basis for bidding and contracting for *structural steel*. However, any other system, rather than the current system based on gross weight as described in Sections 9.2.1 through 9.2.5, can be used as the basis for a contractual agreement. These systems could include net weight, as calculated on the shop drawings, or actual weight, as determined from shipping weight masters, or others, for those products delivered to the site. When other systems are used, both the supplier and the purchaser should clearly understand how the alternative procedure is handled.

9.2.1. The unit weight of steel shall be taken as 490 lb/ft^3 (7 800 kg/m^3). The unit weight of other materials shall be in accordance with the manufacturer's published data for the specific product.

9.2.2. The weights of *standard structural shapes*, plates, and bars shall be calculated on the basis of *fabrication documents* that show the actual quantities and dimensions of material to be fabricated, as follows:

(a) The weights of all *standard structural shapes* shall be calculated using the nominal weight per ft (mass per m) and the detailed overall length.
(b) The weights of plates and bars shall be calculated using the detailed overall rectangular dimensions.
(c) When parts can be economically cut in multiples from material of larger dimensions, the weight shall be calculated on the basis of the theoretical rectangular dimensions of the material from which the parts are cut.
(d) When parts are cut from *standard structural shapes*, leaving a nonstandard section that is not useable on the same contract, the weight shall be calculated using the nominal weight per ft (mass per m) and the overall length of the *standard structural shapes* from which the parts are cut.
(e) Deductions shall not be made for material that is removed for cuts, copes, clips, blocks, drilling, punching, boring, slot milling, planing, or weld joint preparation.

9.2.3. The items for which weights are shown in tables in the AISC *Steel Construction Manual* shall be calculated on the basis of the tabulated weights shown therein.

9.2.4. The weights of items that are not shown in tables in the AISC *Steel Construction Manual* shall be taken from the manufacturer's catalog and the manufacturer's shipping weight shall be used.

Commentary:
Many items that are weighed for payment purposes are not tabulated with weights in the AISC *Steel Construction Manual*. These include, but are not limited to, *anchor rods*, clevises, turnbuckles, sleeve nuts, recessed-pin nuts, cotter pins, and similar devices.

9.2.5. The weights of shop or field weld metal and protective coatings shall not be included in the calculated weight for the purposes of payment.

9.3. Revisions to the Contract Documents

Revisions to the *contract documents* shall be confirmed by change order or extra work order. Unless otherwise noted, the issuance of a *revision* to the *contract documents* shall constitute authorization by the *owner* that the *revision* is *released for construction*. The contract price and schedule shall be adjusted in accordance with Sections 9.4 and 9.5.

9.4. Contract Price Adjustment

9.4.1. When the scope of work and responsibilities of the *fabricator* and the *erector* are changed from those previously established in the *contract documents*, an appropriate modification of the contract price shall be made. In computing the contract price adjustment, the *fabricator* and the *erector* shall consider the quantity of work that is added or deleted, the modifications in the character of the work, and the timeliness of the change with respect to the status of material ordering, detailing, fabrication, and erection operations.

Commentary:
The fabrication and erection of *structural steel* is a dynamic process. Typically, material is being acquired at the same time that the *approval documents* are being prepared. Additionally, the fabrication shop will normally fabricate pieces in the order that the *structural steel* is being shipped and erected.

Items that are revised or placed on hold generally upset these relationships and can be very disruptive to the modeling, detailing, fabricating, and erecting processes. The provisions in Sections 3.6, 4.4.2, and 9.3 are intended to minimize these disruptions to allow work to continue. Accordingly, it is required in *this Code* that the reviewer of requests for contract price adjustments

recognize this and allow compensation to the *fabricator* and the *erector* for these inefficiencies and for the materials that are purchased and the detailing, fabrication, and erection that has been performed, when affected by the change.

9.4.2. Requests for contract price adjustments shall be presented by the *fabricator* and/or the *erector* in a timely manner and shall be accompanied by a description of the change that is sufficient to permit evaluation and timely approval by the *owner*.

9.4.3. Price-per-pound and price-per-item contracts shall provide for additions or deletions to the quantity, type, and character of work that are made prior to the time the *contract documents* are *released for construction*. When changes are made that affect the quantity, type, or character of work after the *contract documents* are *released for construction*, the contract price shall be equitably adjusted.

9.5. Scheduling

9.5.1. If the *design documents* are not *released for construction* at the time of bidding, the contract schedule shall state when the *design documents* will be required to be *released for construction*.

The contract schedule shall state when the jobsite, foundations, piers, and abutments will be ready, free from obstructions, and accessible to the *erector*, so that erection can start at the designated time and continue without interference or delay caused by the *owner's designated representative for construction* (*ODRC*) or other trades.

9.5.2. The *fabricator* and the *erector* shall advise the *owner's designated representatives for design* (*ODRD*) and *ODRC*, in a timely manner, of the effect any *revision* has on the contract schedule.

9.5.3. If the fabrication or erection is significantly delayed due to *revisions* to the requirements of the contract, or for other reasons that are the responsibility of others, the *fabricator* or *erector* shall be compensated for the additional costs incurred.

9.6. Terms of Payment

The *fabricator* shall be paid for *mill materials* and fabricated product that is stored off the jobsite. Other terms of payment for the contract shall be outlined in the *contract documents*.

Commentary:

These terms include such items as progress payments for material, fabrication, erection, retainage, performance and payment bonds, and final payment. If a performance or payment bond, paid for by the *owner*, is required by contract, no retainage shall be required.

SECTION 10. ARCHITECTURALLY EXPOSED STRUCTURAL STEEL (AESS)

10.1. General Requirements

When members are specifically designated as *architecturally exposed structural steel* or *AESS* in the *contract documents*, the requirements in Sections 1 through 9 shall apply as modified in Section 10. Surfaces exposed to view of *AESS* members and components shall be fabricated and erected with the care and dimensional tolerances that are stipulated in Sections 10.2 through 10.6.

Commentary:
The designation of steel as *AESS* adds cost, and that cost is higher as the level of the *AESS* designation increases. However, not all exposed steel requires designation as *AESS*. There are many applications in which the as-produced appearance of fabricated and erected *structural steel* may be deemed sufficient without any special additional work.

10.1.1. The following categories shall be used when referring to *AESS*:

AESS 1: Basic elements
AESS 2: Feature elements viewed at a distance greater than 20 ft (6 m)
AESS 3: Feature elements viewed at a distance less than 20 ft (6 m)
AESS 4: Showcase elements with special surface and edge treatment beyond fabrication
AESS C: Custom elements with characteristics described in the *contract documents*

Commentary:
The categories are listed in the *AESS* matrix shown in Table 10.1. Each category describes characteristics with successively more detailed—and costly—requirements.

- Basic elements in AES*S* 1 are those that have workmanship requirements that exceed what would be done in non-*AESS* construction.
- Feature elements in AESS 2 and 3 exceed the basic requirements, but the intent is to allow the viewer to see the art of metalworking. AESS 2 is achieved primarily through geometry without finish work and treats things that can be seen at a larger viewing distance, like enhanced treatment of bolts, welds, *connection* and fabrication details, and tolerances for gaps, copes, and similar details. AESS 3 is achieved through geometry and basic finish work and treats things that can be seen at a closer viewing distance or are subject to touch by the viewer, with welds that are generally smooth but visible. AESS 3 involves the use of a mock-up and acceptance is based upon the approved conditions of the mock-up.

- Showcase elements in AESS 4 are those for which the designer intends that the form is the only feature showing in an element. All welds are ground and filled, edges are ground square and true. All surfaces are filled and sanded to a smoothness that doesn't catch on a cloth or glove. Tolerances of fabricated forms are more stringent—generally half of standard tolerance. AESS 4 involves the use of a mock-up and acceptance is based upon the approved conditions of the mock-up.
- Custom elements in AESS C are those with other requirements defined in the *contract documents*, which may be more or less stringent than the other categories because individual desired characteristics may be required at the discretion of the specifier.

10.1.2. A mock-up shall be required for AESS 3 and 4. If a mock-up is to be used in other *AESS* categories, it shall be specified in the *contract documents*. When required, the nature and extent of the mock-up shall be specified in the *contract documents*. Alternatively, when a mock-up is not practical, the first piece of an element or *connection* can be used to determine acceptability.

Commentary:
Generally, a mock-up is produced and approved in the shop and subsequently placed in the field. The acceptability of the mock-up can be affected by many factors, including distance of view, lighting, and finishing. The expectations for the location and conditions of the mock-up at time of approval should be defined in the *contract documents*.

10.2. Contract Documents

The following additional information shall be provided in the *contract documents* when *AESS* is specified:

(a) Specific identification of members or components that are *AESS* using the AESS categories listed in Section 10.1.1 and Table 10.1.
(b) Fabrication or erection tolerances that are to be more restrictive than provided for in this section, if any.
(c) For Category AESS C, the *AESS* matrix included in Table 10.1 shall be used to specify the required treatment of the element.
(d) Any variations from the *AESS* characteristics of Table 10.1.
(e) Any other special requirements for *AESS* members and components, such as the orientation of HSS weld seams and bolt heads.

10.3. Approval Documents

All members designated as *AESS* shall be clearly identified to a category, either AESS 1, 2, 3, 4, or C, in the *approval documents*. Tack welds, temporary braces,

backing, and fixtures used in fabrication of *AESS* shall be shown in the *fabrication documents*. Architecturally sensitive *connection* details shall be submitted for approval by the *owner's designated representative for design* prior to completion of the *approval documents*.

Commentary:
Variations, if any, from the AESS categories listed are required to be clearly noted and could include machined surfaces, locally abraded surfaces, and forgings. In addition, if distinction is to be made between different surfaces or parts of members, the transition line or plane must be clearly identified and defined on the *approval documents*.

10.4. Fabrication

10.4.1. The following applies to the *fabricator* with respect to *AESS*:

(a) The *fabricator* shall fabricate and handle the steel with care to avoid marking or distorting the steel members.
(b) Slings shall be nylon-type or chains or wire rope with softeners.
(c) Care shall be taken to minimize damage to any shop paint or coating.
(d) When temporary braces or fixtures are required during fabrication or shipment, or to facilitate erection, care shall be taken to avoid blemishes or unsightly surfaces resulting from the use or removal of such temporary elements.
(e) Tack welds not incorporated into final welds shall be treated consistently with requirements for final welds.
(f) All weld backing and weld runoff tabs shall be removed in accordance with AWS D1.1/D1.1M, AWS D1.8/D1.8M, and ANSI/AISC 341, as applicable.
(g) Bolted *connections* shall have all bolt heads on the same side of the *connection* and shall be consistent from one *connection* to another as specified by the *contract documents*.

Commentary:
The requirements in Sections 10.4.1(f) and 10.6(f) call for the weld backing to be removed in accordance with AWS D1.1/D1.1M, and where the weld joint is part of the designated seismic force-resisting system, to also comply with ANSI/AISC 341 and AWS D1.8/D1.8M.

The requirements in Sections 10.4.1(g) and 10.6(g) do not extend to the "clocking" orientation of the bolt head (or nut).

10.4.2. Fabrication and erection marks shall not be visible for Categories AESS 2, 3, and 4, and mill marks shall not be visible for Categories AESS 3 and 4. Exception: Fabrication marks, erection marks, painted marks, or other marks are permitted to be visible for steel fabricated from reused or weathering steel, or

steel intended to be galvanized or appear uncoated in the completed structure, unless otherwise specified as Category AESS C.

Commentary:
Marks on visible surfaces of a member should not be apparent unless the contract documents require: a) the surface of a reused or reclaimed steel member to appear unchanged, b) the member to remain uncoated or given a clear coat to preserve an uncoated appearance, or c) the member to be galvanized.

10.4.3. The permissible tolerances for member depth, width, out-of-square, and *camber* and sweep shall be as specified in ASTM A6/A6M and ASTM A500/A500M. The following exceptions apply:

(a) For Categories AESS 3 and 4, spliced cross sections shall be matched to meet the acceptance criteria established with mock-up required in Section 10.1.2.
(b) For Categories AESS 2, 3, and 4, the straightness tolerance shall be one-half of that specified in the applicable ASTM standard(s).

Commentary:
The ability to match individual cross sections at a member splice depends on material thickness, mill tolerances for cross-section variation, joint configuration, and the process applied to the member(s) prior to splicing, such as cambering, curving, etc. Members with thinner cross-sectional elements that vary within tolerance may be drawn together more readily than those with thicker elements, and other elements may be so thick they cannot be drawn together to match at the splice. Users are cautioned to explore fabrication costs and capabilities for joining specific member cross sections and to use a mock-up to document expectations. AISC Design Guide 33, *Curved Member Design*, also provides guidance on cross-section distortion for curved members.

10.4.4. For curved structural members, whether composed of a single *standard structural shape* or built-up, the as-fabricated variation from the theoretical curvature shall be equal to or less than the standard *camber* and sweep tolerances permitted for straight members in the applicable ASTM standard.

Commentary:
The curvature tolerance for curved *AESS* members is not reduced from that used for curved non-*AESS* members because curved members have no straight line to sight and the resulting deviations are therefore indistinguishable. See also the Commentary to Section 11.2.2.

10.4.5. For Categories AESS 2, 3, and 4, the straightness tolerance for a built-up member as a whole shall be one-half of that specified in AWS D1.1/D1.1M.

10.4.6. For Categories AESS 3 and 4, copes, miters, and cuts in surfaces exposed to view shall have a gap that is uniform within 1/8 in. (3 mm), if shown to be an open joint. If instead the joint is shown to be in contact, the contact shall be uniform within 1/16 in. (2 mm).

10.4.7. For all categories of AESS, slivers and other similar discontinuities shall be removed and sharp corners resulting from shearing, flame cutting, or grinding shall be eased. For Categories AESS 1, 2, and 3, the surface condition of steel given in ASTM A6/A6M shall be acceptable. For Category AESS 4, local non-typical surface imperfections shall be filled and sanded to meet the acceptance criteria established with the mock-up required in Section 10.1.2.

10.4.8. For Categories AESS 1, 2, 3, and 4, welds shall be continuous in appearance, and weld spatter shall be removed. For Category AESS 4, welds shall be contoured and blended. Where contoured, blended, or seal welds are to be provided for Categories AESS 1, 2, and 3, those welds shall be defined in the *contract documents*.

Commentary:
Intermittent welds are made continuous in appearance, either with additional welding, caulking, or body filler. For corrosive environments, all joints should be seal welded.

10.4.9. For Categories AESS 1 and 2, weld projection up to 1/16 in. (2 mm) is acceptable for butt and plug welded joints. For Categories AESS 3 and 4, welds shall be filled and ground smooth. In no case shall the requirements of ANSI/AISC 341 or AWS D1.8/D1.8M be violated.

10.4.10. For Categories AESS 1, 2, and 3, *weld show-through* shall be acceptable as produced. For Category AESS 4, the weld *show-through* shall meet the acceptance criteria established with the mock-up required in Section 10.1.2.

Commentary:
Weld show-through is a visual indication of the presence of a weld or welds on the opposite surface from the viewer. It is a function of weld size and material thickness and cannot be eliminated in thin material with thick welds. When *weld show-through* is a concern, this should be addressed in the mock-up.

10.4.11. *AESS* surfaces shall be prepared to meet the requirements of the *contract documents* and the specified paint or coating system (see Section 3.1).

10.4.12. For Categories AESS 1 and 2, seams of hollow structural sections shall be acceptable as produced. For Category AESS 3, seams shall be oriented as

specified in the *contract documents*. For Category AESS 4, seams shall be ground, filled, and sanded to meet the acceptance criteria established with the mock-up required in Section 10.1.2.

10.5. Delivery of Materials

The *fabricator* shall use special care to avoid bending, twisting, or otherwise distorting *AESS*. All tie-downs on loads shall be nylon straps or chains with softeners to avoid damage to edges and surfaces of members. The standard for acceptance of delivered and erected members shall be equivalent to the standard employed at fabrication.

10.6. Erection

The following applies to the *erector* with respect to *AESS*:

(a) The *erector* shall use special care in unloading, handling, and erecting *AESS* to avoid marking or distorting the *AESS*. The *erector* shall plan and execute all operations in such a manner that allows the architectural appearance of the structure to be maintained.
(b) Slings shall be nylon-type or chains or wire rope with softeners.
(c) Care shall be taken to minimize damage to any shop paint or coating.
(d) When temporary braces or fixtures are required to facilitate erection, care shall be taken to avoid any blemishes, holes, or unsightly surfaces resulting from the use or removal of such temporary elements.
(e) Tack welds not incorporated into final welds shall be ground smooth.
(f) All weld backing and weld runoff tabs shall be removed, and the welds finished in accordance with Section 10.4.8. Removal, weld finishing, and grinding shall comply with the requirements of AWS D1.1/D1.1M, AWS D1.8/D1.8M, and ANSI/AISC 341, as applicable.
(g) Bolted *connections* shall have all bolt heads on the same side of the *connection* and shall be consistent from one *connection* to another, as specified by the *contract documents*.
(h) For Category AESS 4, open holes shall be filled with weld metal or body filler and smoothed by grinding or filling to the standards applicable to the shop fabrication of the materials.

Commentary:
Weld access holes, as defined by ANSI/AISC 360, should be filled with body filler or other mutually agreed upon nonweldable material. Filling weld access holes with weld metal is discouraged for reasons cited in the commentary to AWS D1.1/D1.1M.

TABLE 10.1
AESS Category Matrix

ID	CHARACTERISTICS	Reference Section	CATEGORY			
			AESS 4 Showcase Elements	AESS 3 Feature Elements in Close View	AESS 2 Feature Elements not in Close View	AESS 1 Basic Elements
1.1	Butt and plug weld reinforcement limited to 1/16 in. (2 mm)	10.4.9			•	•
1.2	Surface preparation to meet paint specification	10.4.11	•	•	•	•
1.3	Sharp edges eased	10.4.7	•	•	•	•
1.4	Continuous weld appearance	10.4.8	•	•	•	•
1.5	Consistent bolt appearance	10.4.1(g)	•	•	•	•
1.6	Weld spatters removed	10.4.8	•	•	•	•
2.1	Mock-ups	10.1.2	•	•	Optional	
2.2	The fabricated product shall have one-half the applicable ASTM or AWS straightness tolerance	10.4.3(b) & 10.4.5	•	•	•	
2.3	Fabrication, and erection marks not visible	10.4.2	•	•	•	
3.1	Mill marks not visible	10.4.2	•	•		
3.2	Butt and plug welds ground smooth and filled	10.4.9	•	•		
3.3	HSS weld seam oriented for reduced visibility	10.4.12	•	•		
3.4	Cross sectional abutting surfaces aligned	10.4.3(a)	•	•		
3.5	Joint gap tolerances minimized	10.4.6	•	•		
4.1	HSS seam treated to comply with mock-up	10.4.12	•			
4.2	Welds contoured and blended	10.4.8	•			
4.3	Surfaces filled and sanded	10.4.7	•			
4.4	Weld show-through to meet acceptance criteria established by mock-up	10.4.10	•			
4.5	Open holes filled	10.6(h)	•			

Notes:
1. AESS C are custom elements with characteristics described in the contract documents.
2. Standard structural steel contains no AESS characteristics.

SECTION 11. FABRICATION AND ERECTION TOLERANCES

11.1. General Requirements

Structural steel shall be fabricated and erected in conformance with the tolerances in this Section and as required in the *contract documents*.

11.2. Fabrication Tolerances

The tolerances on *structural steel* fabrication shall be in conformance with the requirements in Section 11.2.1 through 11.2.8.

Commentary:
Fabrication tolerances are stipulated in several specifications and codes, each applicable to a specialized area of construction. Basic fabrication tolerances are stipulated in this Section. For *architecturally exposed structural steel*, see Section 10. Other specifications and codes are also commonly incorporated by reference in the *contract documents*, such as ANSI/AISC 360, the RCSC Specification, AWS D1.1/D1.1M, AWS D1.5/D1.5M, AIST Technical Report 13 *Guide for the Design and Construction of Mill Buildings*, and the AASHTO Specification.

If the *engineer of record* determines that additional tolerances are required by the design concept, the tolerances should be identified in the *contract documents*, as required by Section 1.11 and ANSI/AISC 360, Section A4.1. The tolerances should be expressed in terms consistent with those found in Section 11, i.e., a description of the parameter to be measured and a tolerance (acceptable deviation from the required parameter).

11.2.1. For members that have both ends finished (see Section 6.2.2) for contact bearing, the variation in the overall length shall be a maximum of plus or minus 1/32 in. (1 mm). For other members that frame to other *structural steel* elements, the variation in the detailed length shall be as follows:

(a) For members that are equal to or less than 30 ft (9.1 m) in length, the variation shall be a maximum of plus or minus 1/16 in. (2 mm).
(b) For members that are greater than 30 ft (9.1 m) in length, the variation shall be a maximum of plus or minus 1/8 in. (3 mm).

11.2.2. For straight and curved structural members, whether of a single *standard structural shape* or built-up, the permitted variation in specified straightness or curvature shall be as listed in Sections 11.2.2.1 and 11.2.2.2. In all cases, completed members shall be free of twists (except as allowed by ASTM standards), bends, and open joints. Sharp kinks or sharp bends shall be cause for rejection.

11.2.2.1 For straight structural members, the variation in straightness shall be equal to or less than that specified for structural shapes in the applicable ASTM standards except when a smaller variation is specified in the *contract documents*.

11.2.2.2 For curved structural members, the variation in the chord length shall be as defined in Section 11.2.1. The variation in curvature measured at the middle ordinate shall be equal to or less than the permissible variations in straightness as specified in applicable ASTM standards for *camber* in the strong direction and sweep in the weak direction, inside or outside of the theoretical arc, except when a smaller variation is specified in the *contract documents*. Should no applicable ASTM standard exist, the variation in curvature measured at the middle ordinate shall be a maximum of plus or minus 1/8 in. (3 mm) times one-fifth the total arc length in ft (times two-thirds the total arc length in m) for members 10 ft (3 m) or greater in length. For members less than 10 ft (3 m) in length, the variation in curvature measured at the middle ordinate shall be a maximum of plus or minus 1/8 in. (3 mm). The middle ordinate is located between work points (W.P.) as shown in Figure C-11.1.

For curved members, the work points shall be defined as follows:

(a) For members other than horizontal members, the member work point shall be the actual center of the member at each end of the shipping piece.

(b) For horizontal members, the work point shall be the actual centerline of the top flange or top surface at each end.

Commentary:
Curved structural members, as referred to in this section, are defined as those members intended to maintain a specified curvature while in use. This section does not apply to members specified for *camber*. The location of the arc length is defined by the contract drawings and may be either at the member's inside radius, the outside radius, or the radius between work points.

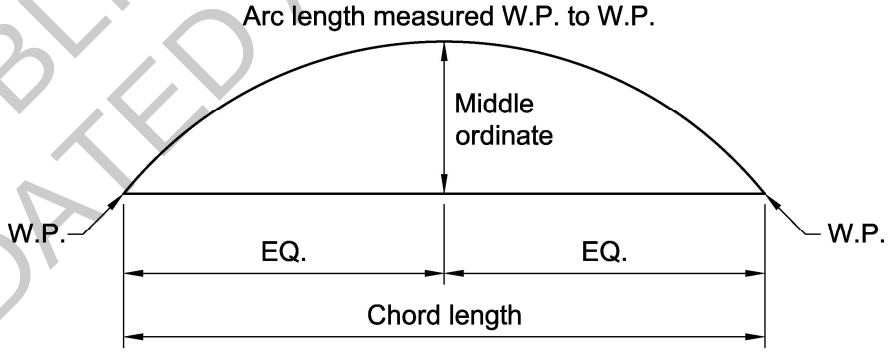


Fig. C-11.1. Illustration of the tolerance on curved structural steel member.

11.2.3. For beams that are detailed without specified *camber*, the member shall be fabricated so that, after erection, any incidental *camber* due to rolling or shop fabrication is upward. For trusses that are detailed without specified *camber*, the components shall be fabricated so that, after erection, any incidental *camber* in the truss due to rolling or shop fabrication is upward.

11.2.4. Beams specified in the *contract documents* as cambered, which are ordered as straight as defined by the applicable ASTM Specification and received by the *fabricator* with 75% of the specified *camber*, shall require no further cambering.

For beams specified in the *contract documents* as cambered, which are ordered as cambered or cambered by the fabricator, the variation in *camber* shall be as follows:

(a) For beams that are detailed equal to or less than 50 ft (15 m) in length, the variation shall be a maximum of minus zero/plus 1/2 in. (13 mm).
(b) For beams that are detailed greater than 50 ft (15 m) in length, the variation shall be a maximum of minus zero/plus 1/2 in. plus 1/8 in. for each 10 ft or fraction thereof (13 mm plus 3 mm for each 3 m or fraction thereof) in excess of 50 ft (15 m) in length.

For the purpose of inspection, *camber* shall be measured in the *fabricator's* shop in the unstressed condition.

Commentary:
Camber can only be properly specified and inspected in the unstressed condition. Inspection is best performed in the shop using established quality control procedures where remedial work, if required, can easily be performed.

Camber cannot be inspected after erection because the effect of dead load and *connection* restraint cannot be accurately determined. See AISC Design Guide 36, *Design Considerations for Camber*, Appendix B.

The *camber* tolerance in this section applies to *camber* induced in the fabrication process, which is done in response to *camber* requirements in the *contract documents*.

In *structural steel* members there are two kinds of *camber*: (1) incidental *camber*, i.e., deviation from straightness, which is controlled by ASTM A6/A6M; and (2) induced *camber* which is specified by the *engineer of record* and is created by the *fabricator* or a supplier. Induced *camber* is controlled by the tolerances in Section 11.2.4. Straight members are subject to the straightness tolerances for sweep and *camber* in ASTM A6/A6M. AISC has recommended that designers not specify *cambers* that are less than 3/4 in. (19 mm) to 1 in. (25 mm).

11.2.5. For fabricated trusses that are specified in the *contract documents* with *camber*, the variation in *camber* at each specified *camber* point shall be a maximum of plus or minus 1/800 of the distance to that point from the nearest point of support. For the purpose of inspection, *camber* shall be measured in the unstressed condition. For fabricated trusses that are specified in the *contract documents* without indication of *camber*, the foregoing requirements shall be applied at each panel point of the truss with a zero *camber* ordinate.

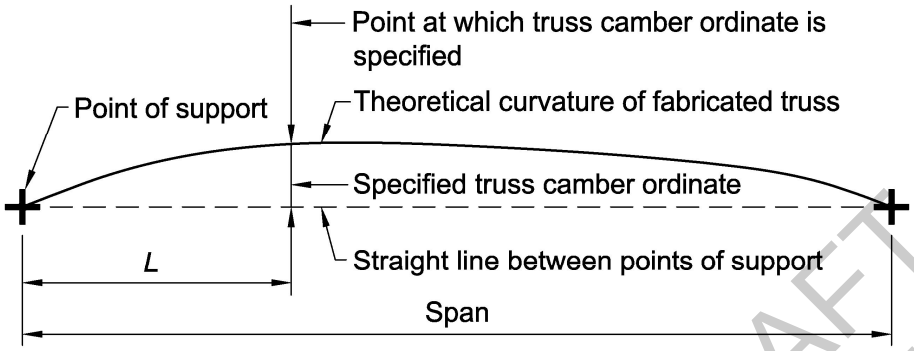
Commentary:
There is no known way to inspect truss *camber* in other than its "unstressed condition" because of factors that include the following:

(a) The effects of the dead weight of the member
(b) The restraint caused by the truss *connections* in the erected state
(c) The effects of additional dead load that may ultimately be intended to be applied, if any

Therefore, for shop fabricated trusses, inspection of the *fabricator's* work on truss *camber* should be done in the fabrication shop in the unstressed condition. See Figure C-11.2. However, it is common practice for field assembled trusses to be ground assembled either in the laydown or shored position and the *camber* should be checked before raising the truss.

11.2.6. When permissible variations in the depths of beams and girders result in abrupt changes in depth at splices, such deviations shall be accounted for as follows:

(a) For splices with bolted joints, the variations in depth shall be taken up with filler plates.
(b) For splices with welded joints, the weld profile shall be adjusted to conform to the variations in depth, the required cross section of weld shall be provided, and the slope of the weld surface shall meet the requirements in AWS D1.1/D1.1M.



Taking *L* as the distance from the point at which truss camber is specified to the closer point of support, in. (mm), the tolerance on truss camber at that point is calculated as *L*/800. *L* must be equal to or less than one-half the span.

Fig. C-11.2. Illustration of the tolerance on camber for fabricated trusses with specified camber.

11.2.7. For holes in base and bearing plates, the variation from the detailed location with respect to the column shaft centerlines shall be a maximum of plus or minus 1/8 in. (3 mm).

11.2.8. The tolerance on overall profile dimensions of welded built-up members shall meet the requirements in AWS D1.1/D1.1M and AWS D1.8/D1.8M for buildings, and AWS D1.5M/D1.5 for bridges.

11.3. Erection Tolerances

Erection tolerances shall be defined relative to member *working points* and working lines, which shall be defined as follows:

(a) For members other than horizontal members, the member work point shall be the actual center of the member at each end of the shipping piece.
(b) For horizontal members, the working point shall be the actual centerline of the top flange or top surface at each end.
(c) The member working line shall be the straight line that connects the member *working points*.

Commentary:
The provision (b) applies at the "top flange" or "top surface" of a horizontal member. It should be noted that this may not be the uppermost point of members, such as trusses with W-shape chords with webs horizontal or trusses with chords skewed from square. The *contract documents* may specify alternative *working points*.

The substitution of other *working points* is permitted for ease of use.

The tolerances on *structural steel* erection shall be in conformance with the requirements in Sections 11.3.1.

Commentary:
The erection tolerances defined in this section have been developed through long standing usage as practical criteria for the erection of *structural steel*. Erection tolerances were first defined in the 1924 edition of *this Code* in Section 7(f), "Plumbing Up." With the changes that took place in the types and use of materials in building construction after World War II, and the increasing demand by *architects* and *owners* for more specific tolerances, AISC adopted new standards for erection tolerances in Section 7(h) of the March 15, 1959, edition of *this Code*. Experience has proven that those tolerances can be economically obtained.

Differential column shortening may be a consideration in design and construction. In some cases, it may occur due to variability in the accumulation of dead load among different columns (see Figure C-11.3). In other cases, it may be characteristic of the structural system that is employed in the design.

Consideration of the effects of differential column shortening may be very important, such as when the slab thickness is reduced, when electrical and other similar fittings mounted on the *structural steel* are intended to be flush with the finished floor, and when there is little clearance between bottoms of beams and the tops of door frames or ductwork.

The effects of the deflection of transfer girders and trusses on the position of columns and hangers supported from them may be a consideration in design and construction. As in the case of differential column shortening, the deflection of these supporting members during and after construction will affect the position and alignment of the framing tributary to these transfer members.

Expansion and contraction in a *structural steel* frame may be a consideration in design and construction. Steel will expand or contract approximately 1/8 in. per 100 ft for each change of 15°F (3 mm per 30 m for each change of 8.3°C) in temperature. This change in length can be assumed to act about the center of rigidity. When anchored to their foundations, end columns will be plumb only when the steel is at normal temperature (see Figure C-11.4). It is therefore necessary to correct field measurements of offsets to the structure from established baselines for the expansion or contraction of the exposed *structural steel* frame. For example, a 200-ft-long (61-m-long) building that is plumbed up at 100°F (38°C) should have *working points* at the tops of the end columns positioned 1/2 in. (13 mm) further apart than the *working points* at the corresponding bases in order for the columns to be plumb at 70°F (21°C). Differential temperature effects on column length should also be taken into account in plumbing surveys when tall *structural steel* frames are subjected to sun exposure on one side.

The Code does not provide explicit tolerances for the vertical position of the top of column shipping pieces at the *tier* splices in a multi-story frame. The design and construction teams need to establish requirements for monitoring the vertical position of the *tier* splices. Performance requirements should be addressed in the *contract documents*. The means of making adjustments should be addressed by pre-planning and mutual agreement among the affected parties prior to the commencement of fabrication and erection.

The alignment of lintels, spandrels, wall supports, and similar members that are used to connect other building construction units to the *structural steel* frame should have an adjustment of sufficient magnitude to allow for the accumulation of mill tolerances and fabrication tolerances, as well as the erection tolerances. See Figure C-11.5.

If the *engineer of record* determines that additional tolerances are required by the design concept, the tolerances should be identified in the *contract documents*, as required by Section 1.11 and ANSI/AISC 360, Section A4.1. The tolerances should be expressed in terms consistent with those found in Section 11, i.e., a description of the parameter to be measured and a tolerance (acceptable deviation from the required parameter).

Tolerances for Complex Structures. During successive stages of erection, certain complex steel framed structures may require significant temporary support, bracing, or other means to maintain geometry and stability during erection to mitigate substantial displacement or indeterminate load paths. These conditions may arise due to the planned sequential application of dead loads, including nonstructural steel elements, during or after completion of the erection of the steel frame. Some examples include, but are not limited to, structures that have nonstructural steel elements in their lateral force-resisting system, structures incorporating cable elements, long span and cantilevered structures, two-way girder or truss-framed structures, and inclined steel frames.

In order to achieve the specified plumb condition, elevation, and alignment of the structure at the completion of the *erector's* work, and to determine the necessary fabrication geometry and preset geometry (*camber* or super-elevation) during erection of these structures, an analytical three-dimensional model should be used by the *fabricator* or *erector* to perform a staged construction analysis and *erection bracing drawings*.

The determination of the fabrication geometry, any preset geometry, and the unstressed and stressed conditions of the steel frame is best achieved through a cooperative approach between the *fabricator*, *erector*, and the *owner's designated representative for design*. The *fabricator* and *erector* should be provided with the same loads and the sequence of application of those loads used by the *owner's designated representative for design*. The *owner's designated representative for construction* should also provide a schedule for the application of the loads cited above for use in the creation of the *erection bracing drawings*.

The *fabricator*, *erector*, and the *owner's designated representative for construction* should not commence work before mutually agreeing as to how and when the requirements of Section 11.3 will be applied.

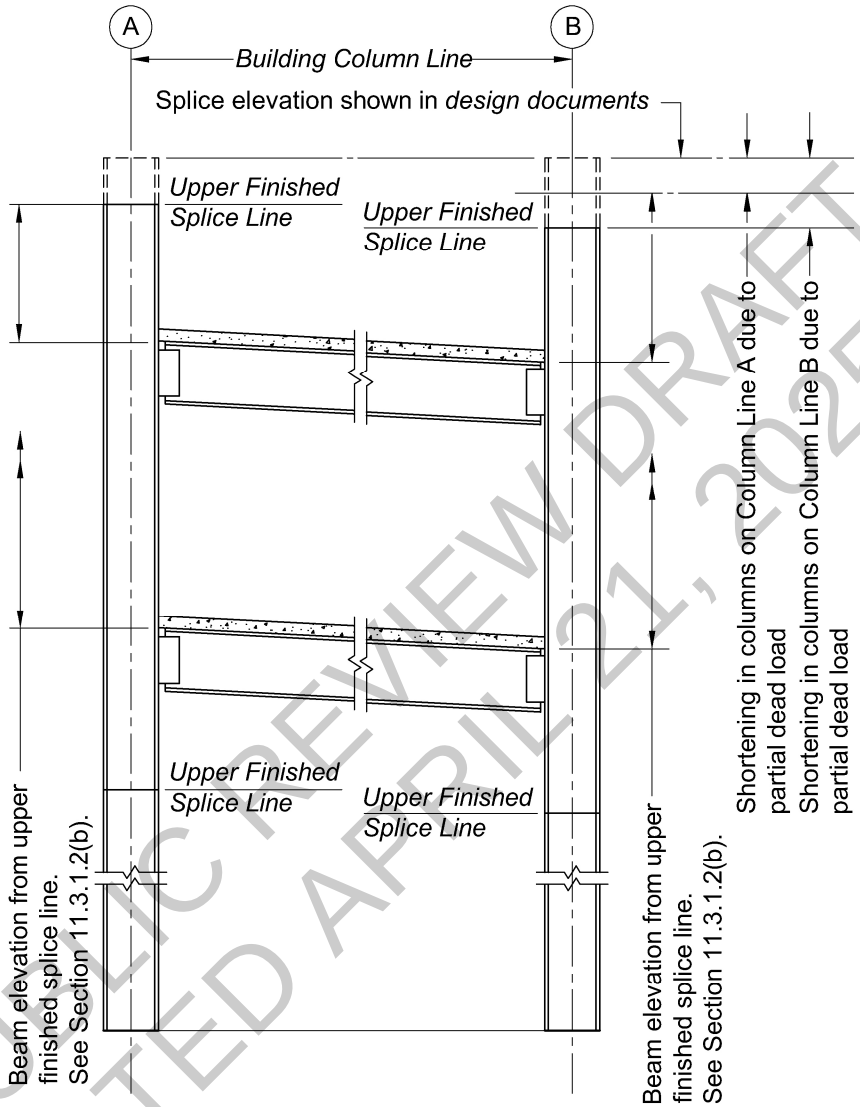


Fig. C-11.3. Effects of differential column shortening.

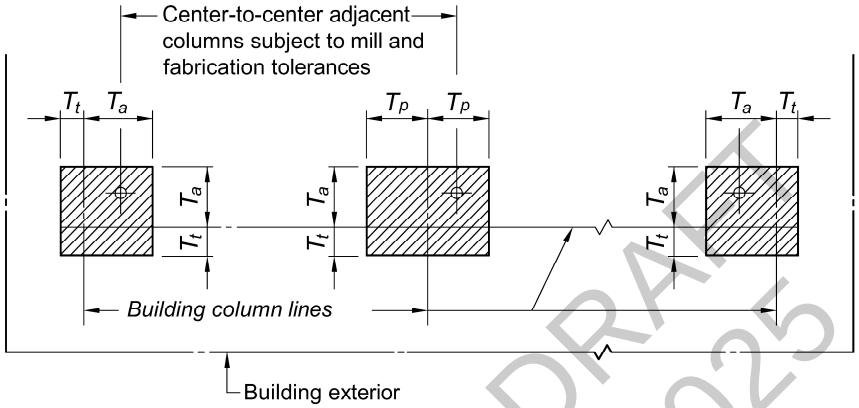
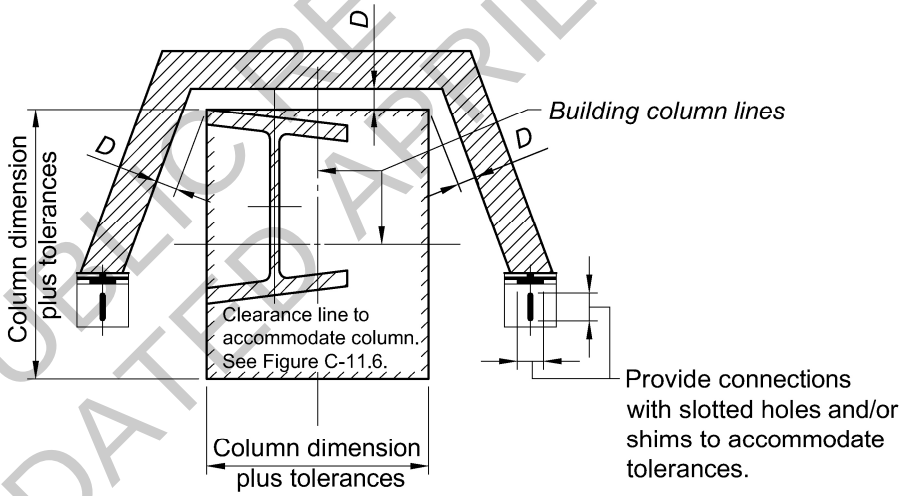


Fig. C-11.4. Tolerances in plan location of column.



D = Tolerance required by manufacturer of wall unit plus survey tolerances.

Fig. C-11.5. Clearance required to accommodate façade.

11.3.1. The tolerances on position and alignment of member *working points* and working lines shall be as described in Sections 11.3.1.1 through 11.3.1.3.

11.3.1.1. For an individual column shipping piece intended to be vertical, the angular variation of the working line from a plumb line shall be a maximum of 1/500 of the distance between *working points*, subject to the following additional limitations:

(a) For an individual column, the horizontal variation in location from the specified position at the base shall be a maximum of 1/4 in. (6 mm) in any direction.

(b) At column splices the variation between the upper column centerline relative to each principal axis and the lower column centerline relative to each principal axis shall be a maximum of plus or minus 1/4 in. (6 mm).

(c) For an individual column shipping piece that is adjacent to an elevator shaft, the displacement of member *working points* shall be a maximum of 1 in. (25 mm) from the *building column line* in the first 20 stories. Above this level, an increase in the displacement of 1/32 in. (1 mm) is permitted for each additional story up to a maximum displacement of 2 in. (50 mm) from the *building column line*.

(d) For an exterior individual column shipping piece, the displacement of member *working points* from the *building column line* in the first 20 stories shall be a maximum of 1 in. (25 mm) toward and 2 in. (50 mm) away from the building exterior. Above this level, an increase in the displacement of 1/16 in. (2 mm) is permitted for each additional story up to a maximum displacement of 2 in. (50 mm) toward and 3 in. (75 mm) away from the building exterior.

Commentary:
The limitations that are described in this section and illustrated in Figures C-11.6 and C-11.7 make it possible to maintain built-in-place or prefabricated facades in a true vertical plane up to the 20th story, if *connections* that provide for 3 in. (75 mm) of adjustment are used. Above the 20th story, the facade may be maintained within 1/16 in. (2 mm) per story with a maximum total deviation of 1 in. (25 mm) from a true vertical plane, if *connections* that provide for 3 in. (75 mm) of adjustment are used. *Connections* that permit adjustments of plus 2 in. (50 mm) to minus 3 in. (75 mm)—a total of 5 in. (125 mm)—will be necessary in cases where it is desired to construct the facade to a true vertical plane above the 20th story.

(e) For an exterior individual column shipping piece, the member *working points* at any splice level for multi-*tier* buildings and at the tops of columns for single-*tier* buildings shall fall within a horizontal envelope, parallel to the exterior *building column line*, that is less than or equal to 1-1/2 in. (38 mm) wide for buildings up to 300 ft (91 m) in length. An increase in the width of

this horizontal envelope of 1/2 in. (13 mm) is permitted for each additional 100 ft (30 m) in length up to a maximum width of 3 in. (75 mm).

Commentary:
This section limits the position of exterior column *working points* at any given splice elevation to a narrow horizontal envelope parallel to the exterior *building column line* (see Figure C-11.8). This envelope is limited to a width of 1-1/2 in. (38 mm), normal to the exterior *building column line*, in up to 300 ft (90 000 mm) of building length. The horizontal location of this envelope is not necessarily directly above or below the corresponding envelope at the adjacent splice elevations but should be within the limitation of the 1 in 500 plumbness tolerance specified for the controlling columns (see Figure C-11.7).

(f) For an exterior column shipping piece, the displacement of member *working points* from the *building column line* that is nominally parallel to the building exterior shall be a maximum of 2 in. (50 mm) in the first 20 stories. Above this level, an increase in the displacement of 1/16 in. (2 mm) is permitted for each additional story up to a maximum displacement of 3 in. (75 mm) in the direction nominally parallel to the building exterior.

(g) For columns bearing on transfer members such as transfer girders and trusses the reference line for column plumbness and position is located at the intersection of the conforming, as-erected center of the transfer member, and the orthogonal *building column line*.

Commentary: As illustrated in Figure C-11.8, the position tolerance for a column bearing on a transfer member is measured at the column location from the transfer member centerline along its longitudinal axis and from the perpendicular *building column line*.

11.3.1.2. For members other than column shipping pieces, the following limitations shall apply:

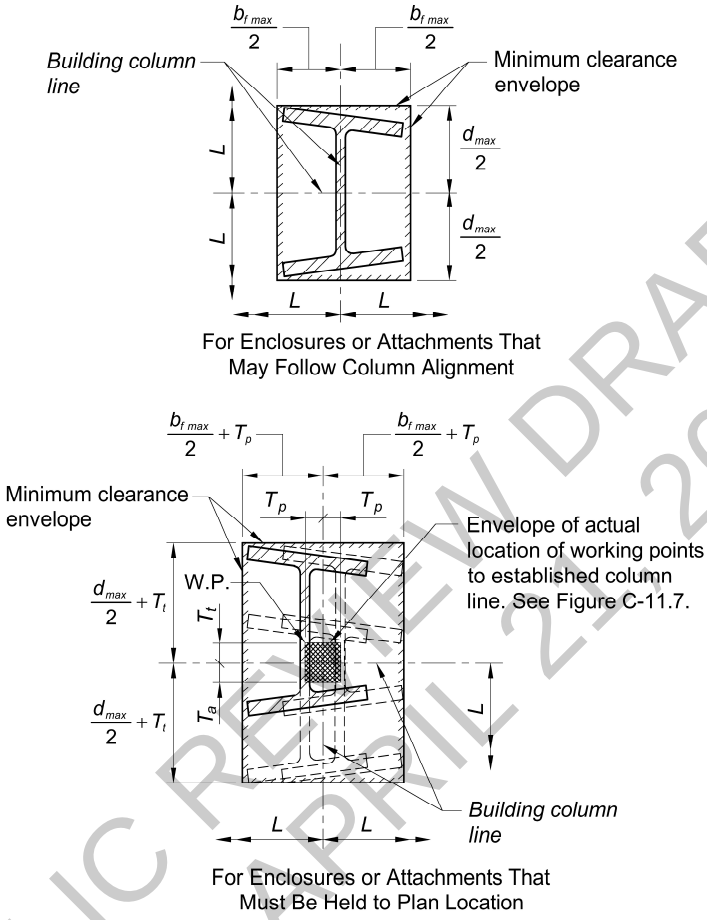
(a) For a member that consists of an individual, straight shipping piece without field splices, other than a cantilevered member, the variation in alignment shall be acceptable if it is caused solely by variations in column alignment or primary supporting member alignment that are within the permissible variations for the fabrication and erection of such members.

(b) For a member that consists of an individual, straight shipping piece that connects to a column, the variation in the distance from the member working point to the *upper finished splice line* of the column shall be a maximum of plus 3/16 in. (5 mm) and minus 5/16 in. (8 mm). These tolerances also apply at the top of a column, either the top column in a multi-*tier* building or a column in a single-*tier* building.

(c) For a member that consists of an individual shipping piece that does not connect to a column, the variation in elevation shall be acceptable if it is caused solely by the variations in the elevations of the supporting members within the permissible variations for the fabrication and erection of those members.

(d) For a member that consists of an individual, straight shipping piece and that is a segment of a field assembled unit containing field splices between points of support, the plumbness, elevation, and alignment shall be acceptable if the angular variation, vertically and horizontally, of the working line from a straight line between points of support is a maximum of plus or minus 1/500 of the distance between *working points*.

Commentary:
Acceptable plumbness, elevation, and alignment is based on the angular misalignment of the working line of all fabricated shipping pieces relative to the line between support points of the member as a whole in erected position not exceeding 1 in 500. Note that the tolerance is not stated in terms of a linear displacement at any point and is not to be taken as the overall length between supports divided by 500. Typical examples are shown in Figure C-11.9. Numerous conditions within tolerance for these and other cases are possible. The condition described in (d) applies to both plan and elevation tolerances.



L = Actual center-to-center of columns = plan dimensions ± column cross-section
tolerance of columns ± beam length tolerance
T_a = Plumbness tolerance away from building exterior (varies, see Figure C-11.7)
T_t = Plumbness tolerance toward building exterior (varies, see Figure C-11.7)
T_p = Plumbness tolerance parallel to building exterior (= T_a)

Notes:
1. $b_{f\,max}$ and d_{max} per ASTM A6/A6M. See Figure C-5.1.
2. The maximum clearance envelope does not include permissible sweep and camber in the column material.

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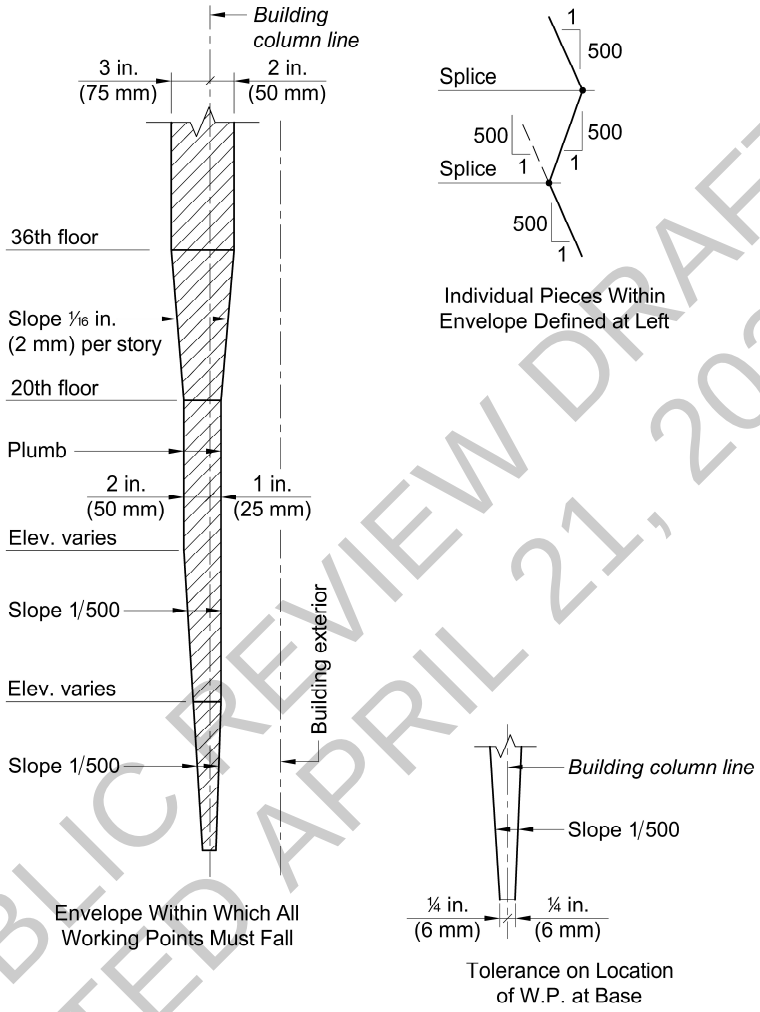
3648 *Fig. C-11.6. Clearance required to accommodate accumulated column tolerance.*



Note: The plumb line through the base working point for an individual column is not necessarily the precise plan location because Section 11.3.1.1 deals only with plumbness tolerances and does not include inaccuracies in location of the building column line, foundations, and anchor rods beyond the erector's model.

Fig. C-11.7. Exterior column plumbness tolerances normal to building line.

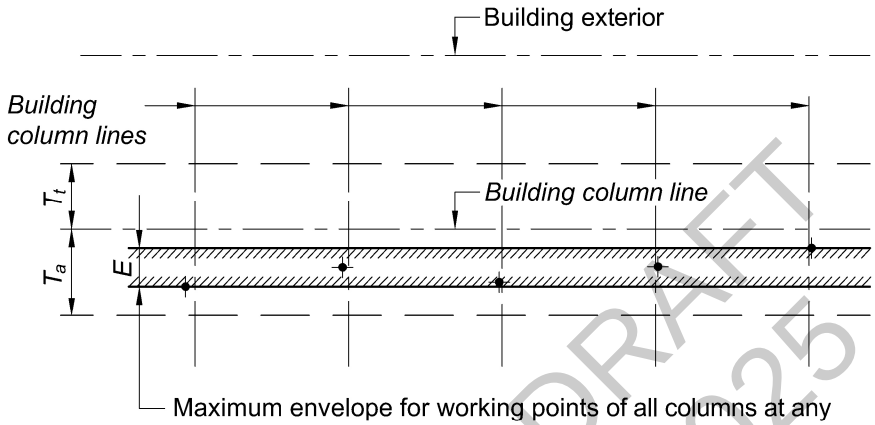


Fig. C-11.8. Tolerances in plan at any splice elevation of exterior columns.

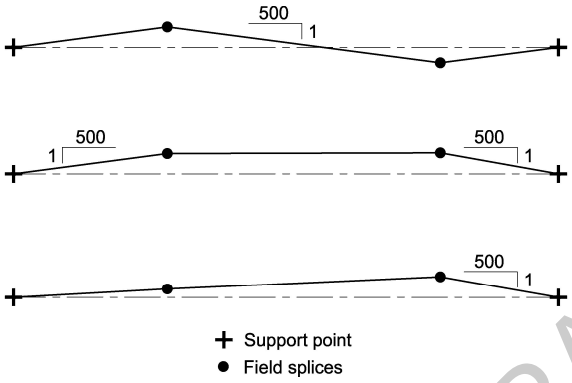


Fig. C-11.9. Alignment tolerances for members with field splices.

(e) For a cantilevered member that consists of an individual, straight shipping piece, the plumbness, elevation, and alignment shall be acceptable if the angular variation of the working line from a straight line that is extended in the plan direction from the working point at its supported end is a maximum of 1/500 of the distance from the working point at the free end.

Commentary:
This tolerance is evaluated after the fixed end condition is sufficient to stabilize the cantilever and before the temporary support is removed. The preset specified in the *contract documents* should be calculated accordingly. The temporary support cannot be used to induce artificial deflection into the cantilever to meet this tolerance after the fixed end is restrained.

(f) For a member of irregular shape, the plumbness, elevation, and alignment shall be acceptable if the fabricated member is within its tolerances and the members that support it are within the tolerances specified in *this Code*.

(g) For a member that is fully assembled in the field in an unstressed condition, the same tolerances shall apply as if fully assembled in the shop.

(h) For a member that is field-assembled, element-by-element, in place, temporary support shall be used or an alternative erection plan shall be submitted to the *owner's designated representatives for design* (*ODRD*) and *construction* (*ODRC*). The tolerance in Section 11.3.1.2(d) shall be met in the supported condition with *working points* taken at the point(s) of temporary support.

Commentary:
Trusses fabricated and erected as a unit or as an assembly of truss segments normally have excellent controls on vertical position regardless of fabrication and erection techniques. However, a truss fabricated and erected by assembling individual components in place in the field is potentially more sensitive to deflections of the individual truss components and the partially completed work during erection, particularly the chord members. In such a case, the erection process should follow an erection plan that addresses this issue.

11.3.1.3. The variation in the position and alignment of *adjustable items* shall be as follows:

(a) The variation in the vertical distance from the reference elevation at each floor to the support location of an *adjustable item* shall be a maximum of plus or minus 3/8 in. (10 mm).

(b) The variation in the horizontal distance provided in the structural design documents using the *control lines* established per Section 7.4 at the particular floor shall be a maximum of plus or minus 3/8 in. (10 mm).

(c) The variation in vertical and horizontal alignment at the abutting ends of *adjustable items* shall be a maximum of plus or minus 3/16 in. (5 mm).

Commentary:
When the alignment of lintels, wall supports, curb angles, mullions, and similar supporting members for the use of other trades is required to be closer than that permitted by the foregoing tolerances for *structural steel*, the *ODRD* is responsible for identifying such items in the *contract documents* as *adjustable items*.

11.3.1.4. For inclined columns, the tolerances of 11.3.1.1(a), (c), (d), and (e) shall also apply at the *working points* of these columns.

11.3.2. In the design of steel structures, the *ODRD* shall provide for the necessary clearances and adjustments for material furnished by other trades to accommodate the mill tolerances, fabrication tolerances, and erection tolerances in *this Code* for the *structural steel* frame.

Commentary:
In spite of all efforts to minimize inaccuracies, deviations will still exist; therefore, in addition, the designs of prefabricated wall panels, partition panels, fenestrations, floor-to-ceiling door frames, and similar elements should provide for clearance and details for adjustment as described in Section 11.3.2. Acceptable designs provide for adjustment in the vertical dimension of prefabricated facade panels that are supported by the *structural steel* frame because the accumulation of shortening of loaded steel columns will result in the unstressed facade supported at each floor level being higher than the *structural steel* framing to which it must be attached. Observations in the field have shown that where a heavy facade is erected to a greater height on one side of a multistory building than on the other, the *structural steel* framing will be pulled out of alignment. Facades should be erected at a relatively uniform rate around the perimeter of the structure.

Metric Conversion Factors for Common Steel Design Units in AISC Specifications

Unit	Multiply	by	to obtain
length	inch (in.)	25.4	millimeters (mm)
length	foot (ft)	0.304 8	meters (m)
mass	pound-mass (lbm)	0.453 6	kilogram (kg)
stress	ksi	6.895	megapascals (MPa), N/mm^2
moment	kip-in.	113 000	N-mm
energy	ft-lbf*	1.356	joule (J)
force	kip (1 000 lbf)*	4 448	newton (N)
force	psf	47.88	pascal (Pa), N/m^2
force	plf	14.59	N/m
force	kip/in.	175.1	N/mm
temperature	To convert °F to °C: $t_c° = (t_f° - 32)/1.8$		

* Force in lbf or N = mass × g, where g, acceleration due to gravity = 32.2 ft/sec^2 = 9.81 m/sec^2