

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section describes the requirements for all labor, material, equipment, permits, engineering and other services necessary for the fabrication and installation of structural steel.
- B. Related Work Specified in Other Sections:
- | | |
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| 1. Submittals | Division 1 |
| 2. Quality Control | Division 1 |
| 3. Concrete Reinforcement and Embedded Assemblies | Section 03 20 00 |
| 4. Cast-In-Place Concrete | Section 03 30 00 |
| 5. Unit Masonry | Section 04 20 00 |
| 6. Steel Decking | Section 05 31 00 |
| 7. Miscellaneous Metal Fabrication | Division 5 |
| 8. Metal Pan Stairs | Division 5 |
| 9. Applied Fireproofing | Division 7 |
| 10. Painting | Division 9 |
| 11. Metal Building Systems | Division 13 |
| 12. Elevators | Section 14 20 00 |

1.2 REFERENCES

- A. Definitions:
1. Structural Drawings: "S" series drawings of the Contract Documents.
 2. Established Column Line: The grid line of column centers indicated in the Contract Documents.
 3. Exposed to View: Readily apparent to the public in normal use of the structure. A view distance of 20 feet is consistent with the intent of this definition.
 4. Heavy Sections: Rolled and built-up sections as follows:
 - a. Shapes included in ASTM A 6/A 6M with flanges thicker than 1-1/2 inches (38 mm).
 - b. Welded built-up members with plates thicker than 2 inches (50 mm).
 - c. Column base plates thicker than 2 inches (50 mm).
 5. SER: Structural Engineer of Record.
 6. Structural Steel: Elements of structural steel frame, as classified by AISC 303.
- B. Building Code: Structural steel work shall conform to the requirements of the Building Code identified on the Structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and the Contract Documents.
- C. Standards: Comply with requirements of the following as modified by the Contract Documents:

1. American Institute of Steel Construction, ANSI/AISC 360, "Specification for Structural Steel Buildings", 2016
2. American Institute of Steel Construction, AISC 303, "Code of Standard Practice," 2016
3. American Welding Society, AWS D1.1, "Structural Welding Code, "2012
4. Research Council on Structural Connections, RCSC - "Specification for Structural Joints Using High Strength Bolts", 2014
5. American Society for Testing and Materials, ASTM, various standards as referenced.

1.3 COORDINATION

- A. Coordinate the Work of this Section with the Work of other Sections.
- B. Provide rigid steel templates for the installation of anchor rods and embeds, labeled and shipped in sets indicating sizes and locations of columns, together with instructions for setting of anchor rods.

1.4 TEMPORARY SUPPORT DURING CONSTRUCTION

- A. The structure as shown on the Contract Documents is designed to withstand the design loads only when all structural elements are installed and fully connected. The contractor shall be responsible for the analysis of all components and assemblies for stresses and displacements that may be imposed by fabrication, shipping, handling, erection, temporary conditions, construction loads, etc. The analysis of such shall be performed by the Contractor's Engineer. Provide temporary shores, guys, braces, and other supports during erection to keep structural steel secure, plumb, and in alignment against temporary construction loads and loads equal in intensity to design loads. Remove temporary supports when permanent structural steel, connections, and bracing are in place unless otherwise indicated.

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Pre-installation Meeting: Conduct meeting at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 1. Require representatives of each entity directly concerned with structural steel framing to attend, including the following:
 - a. Contractor's superintendent.
 - b. Fabricator.
 - c. Erector.
 - d. Surveyor.
 - e. Contractor's Erection Engineer.
 - f. Owner's Testing and Inspecting Agency.
 - g. Design Professional
 2. Review methods and procedures related to structural steel framing including, but not limited to, the following:
 - a. Shop fabrication.
 - b. Galvanizing.
 - c. Shop priming / painting.

- d. Field erection.
 - e. Field surveying.
 - f. Tolerances.
 - g. Bolting.
 - h. Welding.
 - i. Field painting.
 - j. Special inspection and testing and inspecting agency procedures related to installation, tolerances, bolting, and welding.
- B. Minutes of the meeting shall be recorded, typed and distributed by the Contractor to all parties listed above within 5 working days of the meeting. Distribute additional copy to Owner's Representative.

1.6 CONTRACTOR QUALIFICATIONS

- A. The term Structural Steel Contractor refers to any or all of the following parties, regardless of their contractual relationships: Structural Steel Fabricator, Structural Steel Detailer, Structural Steel Erector and Contractor's Engineer.
- B. The Fabricator shall have 10 years of comparable experience in installations of this type and shall employ labor and supervisory personnel familiar with the type of installation, experienced in fabrication and erection of structural steel for projects of similar size and complexity. Fabricator shall be AISC certified to the Standard for Steel Building Structures (STD) and must submit proof of these qualifications. The Fabricator's qualifications shall be subject to review by the Design Professionals and Owner.
- C. The Fabricator shall have specific experience in fabrication of large, welded, built-up sections, long span trusses.
- D. The Fabricator shall be AISC certified with the Sophisticated Paint Endorsement [P1] [P2] [P3] or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."
- E. The Detailer shall have 10 years of experience preparing detailed steel shop drawings for structures of this type and complexity. The detailer's qualifications shall be subject to review by the Design Professionals and Owner.
- F. The Contractor's Engineer(s) shall be qualified to perform the type of work required by the project. The Engineer(s) shall be a Licensed Professional Engineer(s) in the state where the project is located. The Contractor's Engineer(s) shall have 10 years of experience being in responsible charge of work of this nature. The proposed Engineer(s) shall be subject to approval of Design Professionals and Owner.
- G. The Erector shall have 10 years of successful experience erecting structural steel for structures of this type and complexity in the region of the project. Erector shall be an AISC Certified Steel Erector (CSE). Erector shall be an AISC Advanced Certified Steel Erector (ACS0E)
- H. Welders shall have a valid Welding Performance Qualification Record (WPQR) for each welding procedure to be performed. Qualify the welding procedures, shop welders, field welders, welding operators, and tackers in accordance with AWS D1.1 and for the following periods of effectiveness of certification:

1. Certification and qualification, including period of effectiveness of welding personnel shall be as specified by AWS D1 .1. Certification shall remain in effect for duration of work provided welders are continuously engaged in performing the type of welding for which they are certified, unless welders fail to perform acceptable welding, as determined by the Owner's Testing Agency. Certification and re-certification of welding personnel is subject to verification by the Testing Agency. Re-testing for re-certification will be the Contractor's responsibility.

1.7 SUBMITTALS, GENERAL

- A. Submittals for Work of this Section shall be prepared and submitted separately from Submittals for Work of other Sections. Submittals combining Work of this Section with that of other Sections will be returned without review.
- B. Submittals and accompanying correspondence from the Contractor shall not contain clauses defining the meaning or implication of the action taken by those reviewing the Submittal. Submittals not in compliance will be returned without review.
- C. After review of the first re-submittal, review of re-submittals is at Contractor's expense.
- D. Format:
 1. All Submittals, except Samples, shall be submitted in Adobe PDF format with each file being uniquely named.
 2. All Submittals, except Samples, will be returned in Adobe PDF format with each file being uniquely named.

1.8 ACTION SUBMITTALS

- A. Product Data: Submit manufacturers' specifications, test reports, applicable standards and installation instructions for all products listed under Part 2: Products. Standard literature shall be edited to suit job conditions.
- B. Shop Drawings, General
 1. Drawings shall be no larger than 24 inches by 36 inches.
 2. Reproduction of Contract Documents is unacceptable. Do not use the same sheet numbers nor section labels as used on Contract Documents. References to Contract Documents shall not be substituted for complete Shop Drawings.
 3. Cloud the following on each Shop Drawing. Adequacy of unclouded deviations or revisions is Contractor's responsibility regardless of Action taken on Submittal.
 - a. Questions concerning interpretation of Contract Documents.
 - b. Deviations from Contract Documents.
 - c. Revisions incorporated into re-submittals.
- C. Shop Drawings and Erection Drawings (including Field Work drawings): Submit for approval shop drawings and erection drawings for all structural steel indicated on the Contract Documents. Prepare in accordance with AISC 303, AISC 326, and AISC 360.
 - a. Material shall not be fabricated or delivered before the shop and erection drawings have been approved or approved as noted by the Design Professionals and returned to the Contractor.

- b. Structural Steel Shop Drawings: Submitted shop drawings shall include layouts and details for each member showing the steel type and grade, size, connections, cuts, copes, holes, bolts, welds, surface treatments (cleaning, shop paint, etc.) and provisions for the connection of other work. Steel type, grade and size for all attached elements shall also be shown.
 - c. Shop and erection drawings shall contain complete dimensional and geometric information, based on established dimensions shown on Contract Documents, and shall not be scaled from Contract Documents. The shop drawings shall clearly distinguish between shop and field welds and bolts, identify pretensioned high strength bolts and identify surface preparation requirements at slip critical connections. Reproduction of Contract Documents is unacceptable. Do not use the same sheet numbers nor section labels as used on Contract Documents. References to Contract Documents shall not be substituted for complete Shop Drawings.
 - d. Cloud the following on each Shop Drawing. Adequacy of unclouded deviations or revisions is Contractor's responsibility regardless of Action taken on Submittal.
 - 1) Questions concerning interpretation of Contract Documents.
 - 2) Deviations from Contract Documents.
 - 3) Revisions incorporated into re-submittals.
 - e. Welds: All welds shall be indicated by standard welding symbols in the "Standard Code for Arc and Gas Welding in Building Construction" or as accepted by the SER. Shop and erection drawings shall show the size, length, and type of each weld, including the electrode type to be used. Distinguish between shop and field welds
 - f. Bolts: Details for bolt assemblies shall indicate bolt size, length, type and the presence, type and location of washers where required as part of the assembly; distinguish between N and X bolts, distinguish between slip-critical and bearing bolts; and distinguish between shop and field bolts. Also, indicate bolt orientation where required by the Contract Documents.
 - g. Shear Connectors: Identify type, size, and length of shear connectors on composite framing and distinguish between shop and field installed shear connectors
 - h. Erection Drawings: The erection drawings shall include plans showing exact locations of base and bearing plates, and/or anchor rods and other embedded items. All field connections not specifically shown on shop drawings shall be shown on erection drawings, including field bolt size, type, number, location and any special installation requirements, and field weld size, type, length and location.
 - i. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoats.
- D. Structural Connection Design: The Fabricator shall be responsible for designing all connections not provided by the design professional and explicitly shown on the drawings. Where indicated, the Fabricator shall provide details that conform to the conceptual details provided in construction documents. Shop drawings and calculations that include elements designed by the fabricator must be signed and sealed by professional engineer licensed in the project state.
- E. Structural Steel Erection Shop Drawings and Calculations: Submit for approval erection Contractor shall submit an engineered erection procedure by the steel erector bearing the stamp and signature of a licensed engineer in the project state. Steel erection procedure shall include all calculations and procedures necessary to reach the complete and final condition. The structure shall be considered final when construction of the structure plus installation of all

supported elements is complete by all relevant trades. The erection procedure shall include the following information:

1. Structural calculations demonstrating consideration of all loading provisions and temporary stages required during the erection of the structure.
2. Structural calculations specific to the erection means and methods, inclusive of (but not limited to) crane placements, rigging evaluation, and lift load analysis.
3. Deflection calculations corresponding to specific survey measurement points for all intermediate stages of construction. Data shall be provided in terms of project coordinate geometry.
4. Survey procedures, inclusive of all survey points and measurement requirements specific to the erection procedure. Final survey results shall be provided that reference deflection data during each sequence of the erection procedure and compare to the final intended geometry for the purposes of evaluating AISC tolerances.

Erection drawings shall be supplied for all structural steel construction, ~~including conventional steel and Pre-Engineered Metal Building Systems.~~

- F. Samples: Samples shall be provided as requested by the Owner's Testing Agency or Owner's Representative.
- G. Welding Procedures Specifications (WPS): Submit for record written welding procedures for all AWS D1.1 prequalified joints, and qualification procedures for all joints not prequalified by Section 3 of AWS D1.1. Submit supporting Procedure Qualification Record (PQR) as required by AWS D1.1. Submit written welding procedures developed by Contractor's welding consultant for heavy shapes and High Restraint Welds described in this Specification. Use the forms in AWS D1.1, Annex N. Submit weld sequence procedures indicating field welding sequence for each type of connection with multiple field-welded joints, and the sequence of such connections to be field welded at each level. Where shrinkage is likely to cause distortion or other problems, submit a mitigation plan. Submit all welding and qualification procedures to the Owner's Testing Agency for approval before submitting to the Design Professionals.
- H. LEED Submittals:
1. Credit MR 4.1 and Credit MR 4.2: For products having recycled content, documentation indicating percentages by weight of postconsumer and preconsumer recycled content. Include statement indicating cost for each product having recycled content.

1.9 INFORMATIONAL SUBMITTALS

- A. Provide the following submittals for information:
1. Contractor Qualifications
 2. Pre-construction Survey
 3. Erection Procedure
 4. Quality Control Program
 5. Welder Certifications
 6. Mill Reports
- B. Contractor Qualifications: Submit qualification data (personnel, firm resume and project list with references) for each of the following:
1. Contractor's Engineer
 2. Structural Steel Detailer.
 3. Structural Steel Fabricator.

4. Structural Steel Erector.
 5. Welder.
- C. Preconstruction Survey: Where interface with existing construction occurs, before related shop drawings are prepared survey the existing construction and submit the survey prepared by a professional surveyor employed by the Contractor to the Design Professionals. For all steel construction, before steel erection commences, perform and submit to the Design Professionals a complete survey for position and alignment at all points where construction by other trades will support steel elements, including but not limited to pockets, embedded plates, anchor rods and base plates. Include plan location positions relative to the building gridlines, and elevations of bearing surfaces and tops of bolts relative to building Datum elevation.
- D. Quality Control Program: Submit complete details of the Contractor's quality control program including the names of the personnel responsible for this work.
- E. Welder Certification: Submit certification that the welders have passed qualification tests using AWS procedures.
1. A certification shall be submitted in standard AWS format.
 2. Each certification shall state that the welder has been doing satisfactory welding of the required type within the six-month period prior to the subject work.
 3. For any welder whose period of certification effectiveness has lapsed or whose workmanship is subject to question in the opinion of the Design Professionals or Testing Agency, immediate testing for recertification will be required. Tests, when required, shall be conducted at the sole expense of the Contractor.
- F. Mill Reports: Certified copies of all mill reports, covering the chemical and physical properties of all structural steel and accessories (as defined in this Specification) for the project.
1. Such certificates shall be obtained from the mills producing the steel and shall certify in a cover letter submitted with the certificates, that the steel meets the minimum requirements as to physical properties, inspection, marking and tests for structural steel as defined by the current edition of the relevant ASTM Standard Specifications. Any steel that does not meet the ASTM requirements must be clearly identified in a cover letter submitted with the certificates.
 2. Prior to commencing steel erection, the contractor shall deliver certificates to the Owner in number and form as may be required by the local Building Department or other local and State agencies having jurisdiction.
- G. Submittal Process
1. Submittal of shop and erection drawings and other submittals by the Contractor shall constitute Contractor's representation that the Contractor has verified all quantities, dimensions, specified performance criteria, installation requirements, materials, catalog numbers and similar data with respect thereto and reviewed or coordinated each drawing with other Drawings and other trades. The Contractor shall place their shop drawing stamp on all submittals confirming the above.
 2. Shop and erection drawings: Submit in complete packages so that individual parts and the assembled unit may be reviewed together. This Specification Section and the applicable drawings used in the development of the shop and erection drawings shall be referenced on each shop and erection drawing to facilitate checking. Unless the piece marks are self-indexing, furnish index sheets with the shop drawings, relating piece marks for all beam, girder and column details to the sheet numbers on which they are located.
 3. Format:

- a. All Submittals, except Samples, shall be submitted in Adobe PDF format with each file being uniquely named.
 - b. All Submittals, except Samples, will be returned in Adobe PDF format with each file being uniquely named.
4. The Contractor shall allow at least ten (10) working days between receipt and release by the SER for the review of shop and erection drawings and submittals.
5. All modifications or revisions to submittals, shop drawings, and erection drawings must be clouded, with an appropriate revision number clearly indicated. The following shall automatically be considered cause for rejection of the modification or revision whether or not the drawing has been approved by the Design Professionals:
 - a. Failure to specifically cloud modifications.
 - b. Unapproved revisions to previous submittals
 - c. Unapproved departure from Contract Documents
6. Resubmittals: Completely address previous comments prior to resubmitting a drawing. Resubmit only those drawings that require resubmittal.
7. Resubmittals Compensation: The Contractor shall compensate the Design Professionals for submittals that must be reviewed more than twice due to contractors' errors. The Contractor shall compensate the Design Professionals at the standard billing rates plus out-of-pocket expenses incurred at cost + 10%.

H. Submittal Review

1. The review and approval of shop and erection drawings and other submittals by the Design Professionals shall be for general conformance with the design intent of the work and with the information given in the Contract Documents only and will not in any way relieve the Contractor or the Contractor's Engineer from:
 - a. Responsibility for all required detailing.
 - b. Responsibility for the proper fitting of construction work in strict conformance with the contract requirements.
 - c. The necessity of furnishing material and workmanship required by contract Drawings and Specifications which may not be indicated on the shop and erection drawings.
 - d. Conforming to the Contract Documents.
 - e. Coordination with other trades.
 - f. Control or charge of construction means, methods, techniques, sequences or procedures, for safety precautions and programs in connection with the work.

1.10 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

- A. Quality assurance is testing and special inspection to assist the Owner in evaluating the Contractor's performance in the fabrication shop and field. Special inspection is in addition to the testing and inspection performed by the Building Official. It is not a substitute for the testing and inspection which is required as part of the Contractor's quality control program
- B. Testing Agency: Owner will engage and pay a qualified testing and inspecting agency to perform tests and special inspections and prepare test reports.
 1. The Owner has negotiated inspection services based upon the assumption that all fabrication work shall be performed at one single fabrication shop. Costs associated with work being performed in additional shops will require reimbursement to the Owner.

- C. Correct deficiencies in Work, at Contractor's expense, that test reports and inspections indicate does not comply with the Contract Documents. Re-inspection and re-testing shall be at Contractor's expense.
- D. Coordination with Owner's Testing Agency: The Contractor shall have sole responsibility for coordinating their work with the testing agency to assure that all test and inspection procedures required by the Contract Documents and Public Agencies are provided. The Contractor shall cooperate fully with the Owners testing agencies in the performance of their work and shall provide the following:
 - 1. Information as to time and place of starting shop fabrication and a field construction and erection schedule, one week prior to the beginning of the work.
 - 2. Site File: At least one copy of each approved shop drawing shall be kept available in the contractor's field office. Drawings not bearing evidence of approval and release for construction by the Design Professionals shall not be kept on the job. Provide drawings for the work to be performed in the shop or field one week prior to the start of work.
 - 3. Representative sample pieces requested by the inspection agency for testing, if necessary.
 - 4. Full and ample means of assistance for testing and inspection of material.
 - 5. Proper facilities, including scaffolding, temporary work platforms, safety equipment etc., for inspection of the work in shop and field.
- E. Where testing is required for less than 100% of locations, select test locations at random and throughout the project.
- F. Duties of the Owner's Testing Agencies:
 - 1. Reports: Inspection results shall be reported in Adobe PDF format, with each file being uniquely named, to authorities having jurisdiction, Architect, Contractor, and Fabricator within 48 hours of inspection. Specifically indicate items that are in non-compliance with the requirements of the Contract Documents. Reports of inspection of welding shall include deficiencies noted and corrections made, and other items pertinent to acceptance or rejection of the work.
 - 2. Rejection: The Owner's Testing Agency has the right to reject any material, at any time, when it is determined that the material or workmanship does not conform to the Contract Documents. The Testing Agency shall report deficiencies to Owner, Design Professionals, and Contractor immediately.
 - 3. Remedial Work: The Testing Agency shall indicate to the Contractor where remedial work must be performed and will maintain a current list of work not in compliance with the Contract Documents. This list shall be submitted to the Design Professionals and Owner on a weekly basis.
- G. Required Special Inspections:
 - 1. Material verification of structural steel: Periodic.
 - a. Material type and mill certificates
 - b. Alignment
 - c. Straightness
 - d. Levelness
 - e. Plumbness
 - f. Dimension
 - g. Finish bearing ends
 - 2. Material verification of weld filler materials: Periodic.

3. Welded tubes and pipes: Periodic
 - a. Visually inspect seam welds of tube and pipe for evidence of cracking or lack of fusion.
 - b. At each end piece of tube or pipe, inspect interior face of seam weld for evidence of cracking, lack of fusion, or less than full flashing.
4. Welding Procedures: Review welding procedures and welder certification submittals.
5. Inspection of welding:
 - a. Complete joint penetration welds: Continuous.
 - 1) Verify soundness of welds by means of either radiographic or ultrasound testing in accordance with AWS D1.1 and ASTM E164 procedures. For all complete joint penetration welds at top flange of cantilever beams and splices in beam flanges, test for soundness by means of ultrasonic testing and magnetic particle testing. All flaws in plate or flange material revealed during such tests shall be repaired by the Contractor at the Contractor's expense.
 - b. Partial joint penetration welds: Continuous.
 - 1) Verify soundness of welds by means of visual and magnetic particle inspection. All flaws in plate or flange material revealed during such tests shall be repaired by the Contractor at the Contractor's expense.
 - c. Multi-pass and single-pass fillet welds larger than 5/16 inch (8 mm): Continuous.
 - 1) Visually inspect all fillet welds.
 - 2) For all fillet welds at top flange of cantilever beams and splices in beam flanges, test for soundness by means of magnetic particle testing. In addition, test 10% of all fillet welds at other location using a non-destructive method, such as dye penetrant or magnetic particle. Select test locations randomly throughout the structure.
 - d. Single-pass fillet welds 5/16 inch (8 mm) and smaller: Periodic.
6. High restraint welds and at complete or partial joint penetration welds at heavy sections:
 - a. Testing shall be performed not less than 24 hours after the weld has been completed.
 - b. Joint Preparation: Monitor fit up and joint preparation (bevel angle, etc.) for conformance to the submitted welding procedures including preheat and interpass temperature. Monitor base metal temperature during welding operations.
 - c. At heavy sections and high restraint welds, provide pre-production sample testing of heat treatment, observe fabrication, welding and heat treatment of the samples for conformance with submitted welding procedures. Establish locations of testing coupons following AWS procedures. Test coupons following AWS procedures to verify satisfactory results using the welding procedure and heat treatment
 - d. Test complete joint penetration welds in accordance to the requirements of this Specification section, ultrasonically in accordance with AWS D1.1 procedures. On T or corner joints, pay careful attention to the heat affected zone and base metal where the weld shrinkage stresses are in the through thickness direction.

- e. Test partial joint penetration welds in accordance with this Specification section by the magnetic particle method. At T or corner joints, in addition to the magnetic particle testing, ultrasonically scan the heat affected zone and adjacent base metal from face "C" per AWS D1.1 Table 6.7 and Annex K-7 to detect lamellar tears and shall be done with a compression wave. The Testing Agency shall submit a testing procedure that includes evaluation (acceptance criterion) procedures to the Design Professionals for review.
- f. Heavy Sections:
 - 1) Heavy Section flanges shall be ultrasonically examined at locations to be groove-welded, for evidence of laminations, inclusions, or other discontinuities, in accordance with ASTM A898, Straight Beam Ultrasonic Examination of Rolled Steel Structural Shapes (Level 1 criteria). Examination shall include entire area within 3 inches (75 mm) of such joints.
 - 2) For plates, ultrasonically examine in accordance with ASTM A435, Straight Beam Ultrasonic Examination of Steel Plates.
 - 3) Any discontinuity causing a total loss of back reflection that cannot be contained within a circle with a diameter of the greater of 3 inches (75 mm) or one-half the plate or flange thickness, shall be cause for rejection.
- 7. Inspection of steel frame joint details for compliance with approved construction documents including details such as bracing and stiffening, member locations, and application of joint details at each location: Periodic
- 8. Inspection of welded stud connectors, including type, size, length, and weld attachment: Periodic.
 - a. At the beginning of the work shift or any change of operator, equipment, position or setting, perform pre-production testing per AWS D1.1, on the two studs. Verify that two consecutive studs have satisfied pre-production testing prior to starting production welding of studs.
 - b. For production studs, visually inspect all studs for complete fusion and full 360 degree weld flash (or fillet) per AWS D1.1. Check all studs with incomplete fusion or which have been repaired by welding, by bending to an angle of 15 degrees from its original axis (away from any missing flash). Torque test all threaded studs with incomplete fusion. If more than twenty percent of studs fail on one member, check all studs or anchors on member.
 - c. In addition to studs that fail visual inspection, test at random five studs at each of six members per floor. Test additional member for each member with any defective studs or anchors.
 - d. Contractor to replace any studs that crack or break. Contractor to only straighten studs that would foul other work or have less than 1-inch (25mm) cover in bent position.
- 9. Material verification of high-strength bolts, nuts, and washers: Periodic.
- 10. Inspection of high-strength bolting:
 - a. Visually inspect all bolted connections in accordance with RCSC.
 - 1) Pre-installation calibrations and verifications.
 - 2) Surface preparation of members to be joined with slip-critical connections.

- 3) Pretensioning: Verify through routine observation, as defined in RCSC 9.2.1, 9.2.3 or 9.2.4, that the pretensioning methods of RCSC 8.2.1, 8.2.3, or 8.2.4, as appropriate, are performed.
 - a) Exception: Slip critical connections shall be monitored continuously.
 - b) "Routine observation" is defined as observation of 10 bolts for every 100 bolts with a minimum of 2 bolts per connection.

11. Camber:

- a. Randomly selected 10% of beams requiring camber and measure camber within 24 hours after cambering operation.

12. Cleaning, painting, touch up and storage of materials: Periodic.

- H. Certifications: When all work has been approved by the Testing Agency, the Testing Agency shall certify in a letter to the Design Professionals and Owner that the installation is in accordance with the design and Specification requirements including applicable codes.

1.11 CONTRACTOR QUALITY ASSURANCE AND QUALITY CONTROL

- A. The Contractor shall provide a program of quality control to ensure that the minimum standards specified herein are attained.
- B. Structural Steel shall be identified in accordance with the requirements contained in AISC 360. Steel that is not properly identified shall be tested to show conformance with requirements of applicable ASTM Standard at Contractor's expense.
- C. The Contractor shall immediately report to the Design Professionals any deficiencies in the work which are departures from the Contract Documents which may occur during construction. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. After proposed corrective action is accepted by the Design Professionals and Owner, the Contractor shall correct the deficiency at no cost to the Owner.
- D. The Owner's general review during construction and activities of the Owner's Testing Agency are undertaken to inform the Owner of performance by the Contractor but shall in no way replace or augment the Contractor's quality control program or relieve the Contractor of total responsibility for quality control.

1.12 OBSERVATIONS BY DESIGN PROFESSIONALS

- A. Review: The Design Professionals will observe the construction for general compliance with the provisions of the Contract Documents during various phases of construction.
- B. Compensation for Additional Services: Should additional work by Design Professionals such as design, drafting, meetings and/or visits be required which are necessitated by failure of the Contractor to perform the work in accordance with the Contract Documents, the Contractor is responsible for paying for additional work performed by the Design Professionals at their standard firm-wide billing rates plus out-of-pocket expenses incurred at cost + 10%. Additional costs for testing and inspection by the Owner shall also be compensated by the Contractor.

1.13 DELIVERY AND ACCEPTANCE REQUIREMENTS

- A. Deliver materials to Project in such quantities and at such times to ensure continuity of installation.

1.14 STORAGE AND HANDLING REQUIREMENTS

- A. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
 - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.
 - 2. Store structural steel to drain properly. Provide weep holes and clean out as required to keep steel free from water.
- B. Store fasteners in a protected place in sealed containers with manufacturer's labels intact.
 - 1. Fasteners may be repackaged provided Owner's testing and inspecting agency observes repackaging and seals containers.
 - 2. Clean and relubricate bolts and nuts that become dry or rusty before use.
 - 3. Comply with manufacturers' written recommendations for cleaning and lubricating ASTM F1852 and ASTM F2280 fasteners and for retesting fasteners after lubrication.
- C. Store welding material in moisture resistant, undamaged package. Maintain packages effectively sealed until electrode is required for use. Storage and handling shall be per AWS D1.1.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Availability: Confirm availability of all products and notify Architect of any that cannot be provided.
- B. Metal Surfaces: For work that will be exposed to view, use only materials that are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names, and roughness. Remove blemishes by grinding or by welding and grinding prior to cleaning, treating, and application of surface finishes.

2.2 MANUFACTURERS

- A. In other Part 2 Articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, products specified.
 - 2. Products: Subject to compliance with requirements, provide one of the products specified.

3. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
4. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.3 STRUCTURAL STEEL MATERIALS

- A. Recycled Content of Steel Products: Provide products with an average recycled content of steel products so postconsumer recycled content plus one-half of preconsumer recycled content is not less than the following:
 1. W-Shapes: 60 percent.
 - a. Add alternate: 70 percent
 2. Channels, Angles-Shapes: 60 percent.
 3. Plate and Bar: 25 percent.
 - a. Add alternate: 70%
 4. Cold-Formed Hollow Structural Sections: 15 percent.
 - a. Add alternate: 20 percent
 5. Steel Pipe: 25 percent.
 6. All Other Steel Materials: 25 percent.
- B. Structural steel shapes and plates shall conform to the requirements listed on the Structural General Notes.

2.4 ACCESSORIES

- A. Welding Electrodes: Materials shall conform to requirements of AWS D1.1; of suitable type for base metals being welded and the intended application.
 1. Shielded Metal-Arc Welding: Welding electrodes for manual shielded metal-arc welding shall be classified as "low hydrogen" per the Specification for Mild Steel Covered Arc-Welding Electrodes, AWS A5.1, Table 1.
 2. Submerged-Arc Welding: Bare electrodes and granular flux used in submerged-arc welding shall conform to F70 or F80 AWS flux classifications of the specification for Bare Mild Steel Electrodes and Fluxes for submerged-arc Welding, AWS A5.17.
- B. Welded Stud Connectors: End welded by automatically timed stud welding equipment unless otherwise noted.
 1. Welded Headed Studs: ASTM A108, Grades 1015 through 1020, headed-stud type, cold-finished carbon steel; AWS D1.1/D1.1M, Type B.
 2. Threaded Studs: ASTM A108, Grades 1015 through 1020, fully threaded.
 - a. Use with ASTM A563, Grade A, hex nuts and ASTM F844 washers.
 3. Deformed Bar Anchors:
 - a. 3/8" to 5/8" diameter: ASTM A1064 or ASTM A496, 70 ksi minimum yield strength.
 - b. 3/4" or larger diameter: ASTM A706 bars of equal size with complete joint penetration groove weld at end per AWS D1.4

C. High-Strength Bolts, Nuts, and Washers:

1. All bolts shall be new, and not be re-used.
2. A325 bolts:
 - a. ASTM A325 Type 1, heavy-hex steel structural bolts; ASTM A563, Grade C, heavy-hex carbon-steel nuts; and ASTM F436 Type 1, hardened carbon-steel washers; all with plain finish.
 - 1) ASTM F1852, Type 1 "Twist-off" bolt assemblies, round head.
3. A490 bolts:
 - a. ASTM A490 Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH, heavy-hex carbon-steel nuts; and ASTM F436 Type 1, hardened carbon-steel washers with plain finish.
 - b. ASTM F2280, Type 1 "Twist-off" bolt assemblies, round head.
4. A307 bolts
 - a. ASTM A307, Grade A, hex head; ASTM A563, Grade A hex nuts; and ASTM F844 washers; all with plain finish.
5. Direct-Tension Indicators: ASTM F959 type as required to match high strength bolts.

D. Zinc-Coated High-Strength Bolts, Nuts, and Washers:

1. A325 galvanized bolts:
 - a. ASTM A325 (ASTM A325M), Type 1, heavy-hex steel structural bolts; ASTM A563, Grade DH (ASTM A563M, Class 10S) heavy-hex carbon-steel nuts; and ASTM F436 (ASTM F436M), Type 1, hardened carbon-steel washers.
 - b. Finish: Galvanized in accordance with ASTM F2329 and ASTM A153, Class C. Where A588 steel is used, bolts, nuts and washers shall be Type 3.
2. Direct-Tension Indicators: ASTM F959, Type 325 (ASTM F959M, Type 8.8), compressible-washer type with mechanically deposited zinc coating, baked epoxy-coated finish.

E. Anchor Rods:

1. ASTM F1554, Grade 55, weldable.
 - a. Nuts: ASTM A563 heavy-hex carbon steel.
 - b. Plate Washers: ASTM A36/A 36M carbon steel.
 - c. Washers: ASTM F436 Type 1, hardened carbon steel.
 - d. Finish: Plain

F. High Strength Anchor Rods:

1. ASTM F1554, Grade 105
 - a. Nuts: ASTM A194, Grade 2H heavy-hex carbon steel.
 - b. Plate Washers: ASTM A36/A36M carbon steel.
 - c. Washers: ASTM F436 Type 1, hardened carbon steel.
 - d. Finish: Plain

G. Threadbar Anchor Rods:

1. ASTM A615, Grade 75
 - a. Nuts: hex nuts, capable of developing the tensile strength of the Threadbar.
 - b. Plate Washers: ASTM A36/A36M carbon steel.
 - c. Washers: ASTM F436, Type 1, hardened carbon steel.
 - d. Couplers: Stop-Type Couplings, capable of developing the tensile strength of the Threadbar.
2. Available Products:
 - a. All-Thread Rebar by Williams Form Engineering Corp.
 - b. THREADBAR by DYWIDAG-Systems International, USA Inc.

H. Threaded Rods: A572/A572M, Grade 50

1. Nuts: ASTM A563 (ASTM A563M) heavy hex carbon steel.
2. Washers: ASTM F436 Type 1, hardened carbon steel.
3. Finish: Plain

I. Clevises and Turnbuckles: Made from cold-finished carbon steel bars, ASTM A108, Grade 1035.

J. Clevis Pins: ASTM A675, Grade 90, headed. Provide cotter pins and pre-drilled cotter pin holes.

2.5 SHOP COATINGS

- A. Primer: Comply with Division 09 painting Sections.
- B. Primer: SSPC-Paint 25, Type I zinc oxide, alkyd, linseed oil primer.
- C. Primer: SSPC-Paint 25 BCS, Type I zinc oxide, alkyd, linseed oil primer.
- D. Primer: SSPC-Paint 23, latex primer.
- E. Primer: Fabricator's standard lead- and chromate-free, nonasphaltic, rust-inhibiting primer complying with MPI#79 and compatible with topcoat.
- F. Galvanizing Repair Paint: MPI#18, MPI#19, or SSPC-Paint 20 compliant with ASTM A780.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify, with steel Erector present, elevations of concrete- and masonry-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.

1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Anchor Rods: Anchor rods shall be set in conformance with Section 7.5 of AISC 303.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 FABRICATION

- A. Fabricate and assemble structural steel in shop to greatest extent possible. Fabricate according to AISC 303 and AISC 360.
 1. Camber structural steel members where indicated.
 2. Where no camber is indicated, provide natural camber up.
 3. Complete structural steel shop assemblies, including welding of units, before starting shop-priming operations.
- B. Thermal Cutting:
 1. Manual gas-cutting in the shop may be used only if automatic or semi-automatic methods are not possible. If manual shop cutting is required, it shall be done only with a mechanically guided torch, except that an unguided torch may be used where the cut is more than 1/2 inch from the finished dimension and final removal is completed by means such as chipping or grinding to produce a gouge-free surface of quality equal to that of the base metal. At restrained joints and as indicated elsewhere, weld access holes shall be ground smooth.
 2. Where "Heavy Shapes" as defined in this Specification are to be joined by partial or full joint penetration welds in tension, preheating shall be required for all thermal cutting operations. Preheat shall be sufficient to prevent cracking but in no case less than 150°F. Weld access holes and copes shall be ground to a smooth radius after cutting and tested for cracks by the magnetic particle method. All cut edges shall be free of sharp notches and gouges.
 3. Plane thermally cut edges to be welded to comply with requirements in AWS D1.1.
 4. Processes shall be limited to Plasma Arc or Oxyfuel Gas processes, except as approved by Owner's Representative.
 5. Do not use cutting torches in the field without the specific approval of the SER for each application.
- C. Finishing: Accurately finish ends of columns and other members transmitting bearing loads.
- D. Compensate for the difference between the temperature at the time of fabrication and the mean temperature in service.
- E. Hammering which may damage or distort the members will not be permitted.
- F. Steel Wall-Opening Framing: Select true and straight members for fabricating steel wall-opening framing to be attached to structural steel. Straighten as required to provide uniform, square, and true members in completed wall framing.
- G. Welded Door Frames: Build up welded door frames attached to structural steel. Weld exposed joints continuously and grind smooth. Plug-weld fixed steel bar stops to frames. Secure removable stops to frames with countersunk machine screws, uniformly spaced not more than 10 inches on center unless otherwise indicated.

3.3 ERECTION

- A. Erect structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360. Maintain erection tolerances of structural steel in accordance with AISC 303, unless otherwise indicated on the Contract Documents. Align and adjust various members that form part of complete frame or structure before permanently fastening.
- B. Bearing Surfaces: Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact with members. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 - 1. Level and plumb individual members of structure.
 - 2. Compensate for the difference between the temperature at the time of erection and the mean temperature in service.
- C. Column Base:
 - 1. Set plates for structural members on wedges, shims, or setting nuts as required.
 - 2. Tighten anchor rod nuts after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
 - a. Snug tight anchor rod nuts unless otherwise noted.
 - b. Pretension anchor rod nuts at the following locations:
 - 1) Cantilever beam end plates at face of concrete or masonry.
 - 3. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure.
- D. Brace the frame during erection in accordance with the Contractor's erection procedure.
- E. Splice members only where indicated on Drawings or the approved shop drawings. Fasten splices of compression members only after surfaces are cleaned and abutting surfaces have been brought completely into contact. Fill any remaining gaps with steel shims driven into place and cut flush. Tack weld shims to each other and to members. Use runoff tabs at bevel weld splices. Cut off runoff tabs and ground smooth after weld completion.
- F. Where erection requires performing work of fabrication on site, conform to applicable requirements of "Fabrication".
 - 1. Thermally cut edges shall be made with mechanical guides and meet requirements of AWS D1.1, Section 5.15 for acceptable roughness, notches and gouges.
- G. Field corrections will not be permitted without the prior approval of the Owner's Representative.
- H. Additional Material and Labor: If the Contractor furnishes additional material and labor for the purpose of erection or if the erection method requires that material be added to certain members, the required modifications shall be at the sole expense of the Contractor.
- I. Column Length Adjustments:
 - 1. Make allowance in column fabrication lengths for differential shortening between wind columns and non-wind columns acting at different stresses.

2. At a minimum of every 2nd tier (at each column splice), make special provisions to eliminate discrepancies in column elevations, unless noted otherwise on the drawings.

3.4 WELDING

- A. Weld in accordance with AISC 360 and AWS D1.1/D1.1M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
- B. Weld in accordance with welding procedure specifications (WPS's) for joint, which are to be available to welders and inspectors during the production process.
- C. Groove welds shall be complete joint penetration welds, unless designated otherwise on drawings. Groove preparation is at Contractor's option, subject to qualification in accordance with AWS D1.1.
 1. Use double bevel groove welds for sections thicker than 1-1/2 inches.
- D. End dams shall not be used, except at the outboard end of weld tabs that are removed. Provide beveled transitions at changes in groove profile.
- E. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding tolerances in AISC 303 for mill material.
- F. Weld reinforcing steel bar couplers to structural steel in accordance with AWS D1.1 using qualified procedures and in accordance with manufacturer's recommendations.
- G. High restraint welds and welds at heavy shapes:
 1. Follow approved welding procedures for weld process, sequence, pre-heating and cooling. Use stress relieving techniques where shown in the approved procedure developed by the Contractor's Welding Consultant.
 2. Prior to the start of production welding, the contractor shall demonstrate to the Testing Agency that pre-heat can be maintained without relying on heat from the arc. For field welding, the contractor shall provide a shelter to protect each joint from inclement weather (rain, snow, etc.), from start until completion of the joint.
 3. Preheat and Postheat: Preheat shall be sufficient to prevent cracking, but in no case less than required by AWS D1.1. For high-restraint welds, minimum preheat shall be 225°F (105°C). The preheat shall be maintained throughout the thickness of the material for a distance equal to twice the material thickness on both sides of the joint at a minimum. Where different thicknesses of steel are being joined, the greater thickness shall govern. Preheat shall be measured on the face opposite the side of the heat application. Preheat shall be applied uniformly in a manner that does not harm the surface of the material nor cause surface temperatures to exceed 1100°F (600°C). Should stress relief heat treatment be required, the contractor shall submit a written procedure.
 4. Prior to heat treatment on a production weld, prepare and treat a test sample per the contractor's written procedure for tensile and Charpy V-notch tests in accordance with ASTM requirements.
- H. Nonfusible Backing: The use of nonfusible backing materials, including ceramic and copper, is permitted only with satisfactory welder qualification testing performed using the type of backing proposed for use and using the test plate shown in AWS D1.1, Figure 4.21, except that groove dimensions shall be as provided in WPS and PQR. For nonfusible weld tabs and short segments of nonfusible weld backing used at the ends of welds between shear plates and

column faces, or at the ends of continuity plate welds, special welding personnel and welding procedure qualification testing is not required.

I. Welded Joint Details:

1. Welding Backing: The use of weld backing shall be in accordance with AWS D1.1. Weld backing shall be removed where required by the Contract Documents or for the WPS by AWS D1.1
 - a. If groove weld backing is permitted to remain, the backing shall not exceed 3/8 inch (9.5 mm) thickness.
 - b. Heavy Section Splices Requiring Removal of Weld Backing: All welded splices of Heavy Sections, shall have the weld backing removed. Where fusible backing material is used, the root pass area shall be back-gouged after backing bar removal, back-welded until flush or with slight reinforcement. The surface shall then be ground Extra Smooth.
2. Weld Tabs:
 - a. Use of Weld Tabs: Welds shall be terminated at the end of a joint in a manner that will ensure sound welds. Whenever necessary, this shall be done by use of weld tabs.
 - 1) Weld tabs shall extend beyond the edge of the joint a distance equal to a minimum of the part thickness, but not less than 1".
 - 2) Weld tabs shall be oriented parallel to the joint preparation and to the weld direction.
 - 3) Nonfusible weld tabs may be used in applications and locations where qualified in accordance with AWS D1.1, Section 4.
 - b. Heavy Section Joint Weld Tab Removal and Finish: All welded tension splices in Heavy Sections, shall have the weld tabs removed and ground smooth.
3. Weld toes: Weld toes, whether groove welds or fillet welds, shall provide a smooth transition between the weld and base metal. The as-welded profile is adequate provided it satisfies the criteria of AWS D1.1, Section 5.24.
4. Weld access holes:
 - a. Weld access holes shall meet the dimensional, surface finish, and testing requirements of AWS D1.1, except as otherwise required by the Contract Documents.
 - b. Where the height of the weld access hole exceeds the quantity $k-tf+1\frac{1}{2}$ " or where the length of the weld access hole exceeds 4 tf (where k and tf are defined in AISC 360), welded reinforcement is required. Notify the Design Professionals for specific instruction.
5. Welding for Moment Connections shall be sequenced so as to minimize residual stresses in the joint.

- J. Deficient Welds: Welds found deficient in dimensions but not in quality may be enlarged by additional welding. Any weld found deficient in quality shall be removed and repaired in accordance with AWS D1.1, Section 5.26.

- K. Heavy Sections:
1. General: See AISC 360 Chapter A3.1c for materials requirements.
 2. Applicability of Provisions: All requirements of AISC 360 for Group 4 and 5 shapes shall apply to Heavy Sections as defined in this Specification.
 3. Access Hole Requirements: Access holes shall conform to the requirements of AISC 360, Chapter J1.6. Weld access holes must be preheated to a minimum of 150° prior to thermal cutting, ground to an Extra Smooth finish. Inspect holes for cracks using either penetrant testing (PT) or magnetic particle testing (MT). Optionally, weld access holes may be made by drilling and saw-cutting without grinding, but PT or MT of the cut surface is still required.
 4. Welding: The minimum preheat and interpass temperature shall be as specified by AISC 360, Chapter J2.8 Weld tabs and weld backing shall be removed, ground to an Extra Smooth finish, with reinforcement not to exceed 1/8 inch (3 mm), at a transition slope not to exceed 1:10. See AISC 360, J2.8 for preheat requirements and J1.5 for weld tab and backing bar removal requirements.
 5. Splices shall conform to the requirements of AISC 360, Chapter J1.5.
- L. Surface Finish
1. Flush Surfaces: Welds in butt joints required to be flush shall be finished so as to not reduce the thickness of the thinner base metal or weld metal by more than 1/16," or 5% of the material thickness, whichever is less. Remaining reinforcement shall not exceed 1/32" in height. However, all reinforcement shall be removed where the weld forms part of a faying or contact surface. All reinforcement shall blend smoothly into the plate surfaces with the transition areas free from undercut.
 2. Finish Methods and Values: Chipping and gouging may be used, provided these methods are followed by grinding. Where surface finishing is required, surface shall be Extra Smooth, unless otherwise noted or specified in this document. Measurement of surface finish values by visual appearance or tactile comparison is acceptable.
- M. Repair of Gouges: Gouges are not permitted in areas requiring and Extra Smooth finish surface, or where specifically prohibited by AWS D1.1 or this Specification. Repair of gouges shall meet the following requirements, unless otherwise noted:
1. Shallow Gouges: Gouges up to 3/16" deep shall be removed by grinding as per D1.1, or to a radius of not less than 3/8".
 2. Deep Gouges: Gouges deeper than 3/16" shall be repaired by welding. Prior to welding, gouges shall be ground to provide an Extra Smooth contour with a radius not less than 3/8". The repair area shall be preheated to a temperature between 400° F and 550°F, measured at the point of welding approximately one minute after removal of the heating source, or shall be preheated in accordance with AWS D1.1 Annex I for high restraint. A written repair WPS for the application shall be followed. Following completion of welding, the area shall be ground Extra Smooth, with fairing of the welded surface to adjoining surfaces where applicable, and shall be inspected using magnetic particle testing (MT).
 3. The transitional slope after gouge removal shall not exceed 1:5.
- N. Bearing:
1. Bearing ends of columns shall be milled or sawn square perpendicular to axis of the column.
 2. Finish bearing areas of base plates per AISC M2.8.
- O. Stiffeners: Fitted stiffeners shall be ground to fit closely against flanges.

3.5 WELDED STUD CONNECTORS

- A. End weld stud connectors with an automatic process in accordance with section 7 of AWS D1.1.
- B. Areas to which studs are to be attached must be free of foreign material, such as rust, oil, grease, paint etc. When mill scale is sufficiently thick to cause difficulty in obtaining proper welds, remove by grinding or sand blasting.
- C. Remove ceramic ferrules from studs and work after welding.

3.6 BOLTING

- A. Bolts shall be driven accurately into the holes without damaging the threads. Bolt heads shall be protected from damage during driving. Bolt heads and nuts shall rest squarely against the metal. Where bolts are to be used on beveled surfaces having slopes greater than 1 in 20 with a plane normal to the bolt axis, beveled washers shall be provided to give full bearing under the head or nut.
- B. High Strength Bolts:
 - 1. Install high-strength bolts according to RCSC for type of bolt and type of joint specified.
 - 2. Fully Pretension, except where otherwise designated on Drawings, using one of the following methods:
 - a. Turn-of-Nut Pretensioning
 - b. Twist-Off Type Tension Control Bolt
 - c. Pretensioning or Direct-Tension-Indicator (DTI)
 - d. Calibrated Wrench Pretensioning shall only be used where specifically approved by the SER.
 - 3. Comply with special washer requirements of the RCSC, such as those related to slotted and oversize holes, and tapered flanges. DTI "washers" shall not be substituted for such required washers.
 - 4. All high strength bolt assemblies (including Tension Control bolts and DTI's) used in pretensioned connections shall be verified in accordance with the Pre-Installation Verification section of the RCSC.
 - 5. Clean and re-lubricate bolts and nuts that become dry or rusty before use, except Tension Control bolts must be re-lubricated by manufacturer.
- C. Connections designated as slip critical on the Drawings, A325SC or A490SC:
 - 1. Prepare Class A faying surfaces.
- D. Bolts indicated as "finger tight" on the Contract Documents shall be prevented from backing off by using lock nuts or applying threadlocker compound.
- E. For all bolts except for A490 bolts, provide hot dip galvanized fasteners for connections to galvanized members.
- F. Bolt Holes:
 - 1. Standard, except where noted otherwise on Drawings.
 - 2. Cut, drill, or punch bolt holes perpendicular to metal surfaces.

3. Do not punch holes in material greater than 1/2 inch (13 mm) in thickness, unless approved in writing by Owner's Representative.
 4. Holes shall not be made or enlarged by burning. Burning or drifting unfair holes will not be permitted.
 5. Holes that must be enlarged shall be reamed, but only up to the next larger bolt size. Where unfairness exceeds the maximum, weld hole in base material solid and drill hole of proper size.
- G. Driftpins will be allowed only to bring together the several parts for connection and shall not be used in such a manner as to distort or damage the metal.
- H. Erection bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces. On non-exposed welded construction, remove erection bolts.

3.7 SHOP COATING

- A. Shop prime steel surfaces except the following:
1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches (50 mm).
 2. Surfaces within 6 inches (150 mm) of field welds.
 3. Surfaces to be high-strength bolted with slip-critical connections.
 4. Surfaces required for testing and preheat, until all testing and preheat has been performed.
 5. Finished bearing surfaces (use removable rust-inhibiting coating).
 6. Top surface of beams to receive welded shear connector studs or welded attached steel deck.
 7. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
 8. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to the following specifications and standards:
1. SSPC-SP 2, "Hand Tool Cleaning."
 2. SSPC-SP 3, "Power Tool Cleaning."
 3. SSPC-SP 7/NACE No. 4, "Brush-Off Blast Cleaning."
 4. SSPC-SP 11, "Power Tool Cleaning to Bare Metal."
 5. SSPC-SP 14/NACE No. 8, "Industrial Blast Cleaning."
 6. SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 7. SSPC-SP 10/NACE No. 2, "Near-White Blast Cleaning."
 8. SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning."
 9. SSPC-SP 8, "Pickling."
 10. Interior, Not Exposed to View (above suspended ceilings, under sprayed-on fireproofing, steel to be encased in concrete): SSPC-SP-2, Hand Tool Cleaning.
 11. Interior, Exposed in the Finished Building: SSPC-SP-6, Commercial Blast Cleaning, unless noted otherwise on the Drawings.
 12. Exterior (exposed to weather or in unconditioned space): SSPC-SP-6, Commercial Blast Cleaning, unless noted otherwise on the Drawings.
 13. Architecturally Exposed Structural Steel where indicated on the Contract Documents as "AESS": SSPC-SP-10, Near White Blast.
 14. Members to be Hot Dipped Galvanized: SSPC-SP3, Power Tool Cleaning, before galvanizing.
 15. Steel surfaces that are to remain unpainted: SSPC-SP1

- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils (0.038 mm). Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.
 - 2. Apply two coats of shop paint to surfaces that are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.
- D. Painting: Prepare steel and apply a one-coat, nonasphaltic primer complying with SSPC-PS Guide 7.00, "Painting System Guide 7.00: Guide for Selecting One-Coat Shop Painting Systems," to provide a dry film thickness of not less than 1.5 mils (0.038 mm).

3.8 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A123/A123M.
 - 1. Obtain approval from Owner's Representative for locations of vent holes.
 - 2. Fill vent and drain holes that will be exposed in the finished Work unless they will function as weep holes, by plugging with zinc solder and filing off smooth.
- B. Members in the following locations shall be galvanized:
 - 1. Lintels, shelf angles, and welded door frames attached to structural steel frame and located in exterior walls.
 - 2. All members in exposed or potentially wet environments.
 - 3. All members in exterior locations.
 - 4. All members indicated.

3.9 ASPHALTIC PAINT

- A. Coat all steel surfaces below slabs-on-grade with asphaltic paint to a minimum thickness of 18 mils.

3.10 FIELD TOUCH-UP PAINTING

- A. Touchup Painting: Immediately after erection, clean exposed areas where primer is damaged, exposed surfaces of bolts, bolt heads, nuts, washers, all field welds and areas adjacent to field welds. Paint with the same material as used for shop painting to comply with SSPC-PA 1 for touching up.
 - 1. Clean and prepare surfaces by SSPC-SP 2 "Hand-Tool Cleaning" or SSPC-SP 3 "Power-Tool Cleaning."
- B. Galvanized Surfaces: Clean areas where galvanizing is damaged or missing and repair galvanizing to comply with ASTM A780.

3.11 CLEANING

- A. After erection, thoroughly clean surfaces of foreign or deleterious matter such as dirt, mud, oil, or grease that would impair bonding of fire-retardant coating, paint or concrete.

END OF SECTION