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SECTION 051200– STRUCTURAL STEEL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

- A. The drawings and general conditions of the contract including General and Supplementary Conditions and other Division 1 Specification sections apply to work of this section.
- B. Examine all other sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- C. Coordinate work with that of all trades affecting or affected by work of this Section. Cooperate with such trades to assure the steady progress of all work under the Contract.

1.02 DESCRIPTION OF WORK:

- A. Extent of structural steel work is shown on drawings, including schedules, notes and details to show size and location of members, typical connections, and type of steel required.
- B. Structural steel is that work defined in AISC “Code of Standard Practice” and as otherwise shown on drawings.

1.03 RELATED WORK

- 1. Section 5 – Open Web Steel Joists
- 2. Section 5 – Metal Deck
- 3. Section 5 – Metal Fabrications

1.04 QUALITY ASSURANCE:

- A. Codes and Standards: Comply with latest provisions of the following, except as otherwise indicated:
 - 1. AISC “Code of Standard Practice for Steel Buildings and Bridges”, Latest Edition.
 - a. The provisions of Section 10, “Architecturally Exposed Structural Steel”, apply to exposed steel elements for this project. In addition, exposed welds shall be ground to provide smooth surface.
 - b. Exclude the word “structural” in reference to the “Design Drawings” in section 3.1 of the Code.

2. AISC "Specification for Structural Steel Buildings", including "Commentary" and Supplements issued thereto.
 3. AISC "*Specifications for Structural Joints using ASTM A 325 or A 490 Bolts*" approved by the Research Council on Structural Connections of the Engineering Foundation.
 4. AISC 341, "Seismic Provisions for Steel Buildings".
 5. AWS D1.1 - "Structural Welding Code" - Steel.
 6. AWS D1.3 - "Structural Welding Code" - Sheet Steel.
 7. ASTM A6 "General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use."
 8. "Code of Federal Regulations, Part 1926" per the Occupational Safety and Health Administration (OSHA), Department of Labor (Latest Revision).
- B. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS D1.1 "Standard Qualification Procedure."
1. Provide certification that welders to be employed in work have satisfactorily passed AWS D1.1 qualification tests and maintained a current certification. Current certification and/or continuity log shall be submitted and be available in the field.
 2. If re-certification of welders is required, retesting will be the Contractor's responsibility.
- C. Fabricator Qualifications: Fabricator must be a member of the American Institute of Steel Construction (AISC), be certified for SBD – Conventional Steel Building Structures, STD – Standard for Steel Building Structures. Fabricator shall be certified at time of bidding and for duration of project.

1.05 SUBMITTALS

- A. Unless otherwise specified, submittals required in this section shall be submitted for review. Submittals shall be prepared and submitted in accordance with this section and Division 1.
- B. General Contractor shall submit a Submittal Schedule to the engineer within 30 days after they have received the Owner's Notice to Proceed.
- C. All submittals shall be reviewed and returned to the Architect within 10 working days.

- D. INCOMPLETE SUBMITTALS WILL NOT BE REVIEWED.
- E. Submittals not reviewed by the General Contractor prior to submission to the Engineer will not be reviewed. Include on the submittal statement or stamp of approval by Contractor, representing that the Contractor has seen and examined the submittal and that all requirements listed in Division 1 have been complied with.
- F. Engineer will review submittals a maximum of two review cycles as part of their normal services. If submittals are incomplete or otherwise unacceptable and re-submitted, General Contractor shall compensate Engineer for additional review cycles.
- G. Hardcopy Submittals: Submit three prints. Prints will be reviewed by the Engineer, and then the Architect. One marked print will be returned to Contractor for printing and distribution. Multiple copies will not be marked by the Engineer.
- H. Electronic Submittals:
 - 1. Contractor shall include in the submittal schedule an indication of submittals that are intended to be submitted electronically. Upon receipt of the submittal schedule, the Engineer reserves the right to indicate submittals that will not be accepted electronically. Paper copies of such submittals shall be furnished as referenced in this specification.
 - 2. The Engineer reserves the right to require paper copies of submittals that are received electronically. Provide Engineer one (1) paper copies in addition to the electronic submittal. Paper copy will be retained and electronic copy will be returned. Review cycle for such submittals shall not commence until such time that the paper copies are received.
 - 3. Electronic Submittals shall be submitted in Protected Document Format (PDF) compatible with Adobe Acrobat Professional version 7.0 or later. Electronic files shall not be broken into smaller individual files. File sizes too large to process email or within a file transfer protocol (FTP) site shall be provided on a CD.
 - 4. The submission of submittals electronically does not relieve the contractor of their responsibility to review the submittal prior to transmission to the Engineer. Electronic Submittals shall include contractor comments, and a statement and/or stamp of approval by Contractor, representing that the Contractor has seen and examined the submittal and that all requirements listed in this Section and Division 1 have been complied with. Electronic submittals without the Contractor's approval will be rejected and returned.

5. The Engineer assumes no responsibility for the printed reproduction of submittals reviewed electronically, transmission errors or returned electronic submittals that become corrupted or are otherwise not accessible by the Contractor's or Subcontractor's computer hardware and/or software.
- I. Product Data: Submit producer's or manufacturer's specifications and installation instructions for the following products. Include laboratory test reports and other data to show compliance with specifications (including specified standards).
 1. Structural steel certified mill reports for each grade of steel covering chemical and physical properties and yield strengths.
 2. High-strength bolts (each type), including nuts and washers.
 3. Structural steel primer paint (where applicable).
 4. Structural steel top coat paint (where applicable). (Refer to Section 9.)
 5. AWS D1.1 Welder certifications.
 6. Expansion/Adhesive Anchors (coordinate with section 3).
 - J. Fabricator's Quality Control Procedures: Fabricator shall submit their written procedural and quality control manuals, and evidence of periodic auditing of fabrication practices by an approved inspection Agency.
 - K. Fabricator's Certificate of Compliance: At completion of fabrication, fabricator shall submit a certificate of compliance stating that the work was performed in accordance with the construction documents.
 - L. Shop Drawings:
 1. Shop Drawing Review: Electronic files of structural drawings will not be provided to the contractor for preparation of shop drawings. Reproduction of any portion of the Construction Documents for use as Shop drawings and/or Erection Drawings is prohibited. Shop drawings and/or Erection drawings created from reproduced Construction Documents will be returned without review.
 - a. Review of the shop drawings will be made for the size and arrangement of the members and strength of the connections. Conformance of the Shop Drawings to the Contract Drawings remains the responsibility of the General Contractor. Engineer's review in no way relieves the General Contractor of this responsibility.

- b. Shop drawings will not be reviewed as partial submittals. A complete submittal shall be provided and shall include; erection and piece drawings indicating all members, braced frames, moment frames and connections. Incomplete submittals will not be reviewed.
 2. Connection Design: Submit design calculations prepared and stamped by a Professional Engineer registered in the State of Maine for all beam and column connections not tabulated in the AISC “Manual of Steel Construction” (ASD or LRFD). Submit design for all building braced frames and moment frames where applicable, as indicated on design drawings. Connection designs shall be submitted prior to or with the Shop Drawing Submittal.
 - a. Fabricator and Erector are responsible to provide connections that meet the requirements of AISC standards. All shop and field welds, bolts, plates and miscellaneous components required to provide complete connection assemblies shall be provided.
 - b. Unless indicated otherwise, simple shear connections shall be provided for the full uniform load capacity of the beam for non-composite construction, and 1.5 times the full uniform load capacity of the beam for composite construction. All connections shall have a minimum of 2 bolts rows in the line of force, and no connection capacity shall be less than 10 kips (unfactored). A tabulation of the simple shear connections shall be provided with the connection submittal.
 - c. Braced frame connections: A brace force has been provided on the drawings.
 - d. Braced frame connections shall be designed utilizing the Uniform Force Method, with a connection geometry that does not induce a moment on the connected beam or column.
 - e. To the greatest extent possible and where required herewithin, welds shall be designed and detailed to be installed downhand.
 - f. Column splices shall be designed and detailed per AISC standards. Column splices at braced frames and/or moment frames shall develop the full capacity of upper section.
 3. Test Reports: Submit copies of reports of tests conducted on shop and field bolted and welded connections. Include data on type(s) of test conducted and test results.
 4. LEED Documentation: Refer to paragraph 1.07 of this section.

1.06 DELIVERY, STORAGE AND HANDLING:

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- A. Deliver materials to site at such intervals to insure uninterrupted progress of work.
- B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place, in ample time to not delay work.
- C. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
- D. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Steel materials shall be stored in a manner to avoid ponding of precipitation on members. Repair or replace damaged materials or structures as directed.

1.07 LEED Requirements:

- A. Material Recycled Content: Structural Steel shall be meet the following minimum recycled content:
 - 1. The sum of the post consumer recycled content + $\frac{1}{2}$ the sum of pre-consumer recycled content: 80% Minimum
 - 2. Submit invoices and documentation from manufacturer of the amounts of post-consumer and post-industrial recycled content by weight for products with specified recycled content.
- B. Local/Regional Materials: Structural steel source (mill) and fabricator shall be located within 500 miles of the project location. Submit documentation of manufacturing locations and origins of materials for products manufactured within 500 miles of the project site.
- C. Waste Management: Collect offcuts and scrap and place in designated areas for recycling.

PART 2 PRODUCTS

2.01 MATERIALS:

- A. Structural Steel Shapes, Plates and Bars (U.N.O): ASTM A 36 minimum, higher strength steel is acceptable.
- B. Structural Steel Hot Rolled Wide Flange Shapes: ASTM A 992 Grade 50 (ASTM A572 Grade 50 with special requirements per AISC Technical Bulletin #3, dated March 1997)
- C. Steel Tube: ASTM A 500, Grade B, $F_y = 46$ ksi.
- D. Steel Pipe: ASTM A 53, Grade B.

- E. Anchor Bolts: ASTM F1554, Grade 36 weldable steel, unless noted otherwise on drawings. Anchor rods that are to be exposed to weather, located in unheated enclosures, or in contact with pressure treated lumber shall be hot dipped galvanized. All anchor bolts shall be headed or double nutted. "J" or "L" type anchor bolts are not permitted. Unless otherwise noted, specified embedment it to top face of head or nut.
- F. Unfinished Threaded Fasteners: ASTM A 307, Grade A, regular low-carbon steel bolts and nuts. Provide hexagonal heads and nuts for all connections.
- G. High-Strength Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts, and hardened washers, as follows:
 - 1. Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A325 or ASTM A490. Refer to drawings for diameter.
 - 2. Direct tension indicator washers or bolts may be used at Contractor's option.
 - 3. Provide hot-dipped galvanized fasteners at relieving angles.
- H. Steel Shear Studs: Headed type manufactured from steel conforming to ASTM A108 Grade C1015 by KSM or Nelson. Refer to Drawings for diameter and length.
- I. Electrodes for Welding:
 - 1. Minimum 70 ksi electrodes. Filler material shall meet the grouping requirements per AWS D1.1 Table 3.1 for matching strength of connected materials.
 - 2. All filler metal used welding shall meet the following Charpy V-Notch (CVN) requirements.
 - a. 20 ft-lb at 0 degrees Fahrenheit unless noted otherwise.
 - b. 20 ft-lb at -20 degrees Fahrenheit and 40 ft-lb at 70 degrees Fahrenheit at all complete joint penetration (CJP) groove welds.
- J. Structural Steel Coatings shall be as specified in the Structural Steel Coatings section of this specification, and as specified in Division 9.
- K. Steel Coatings for Exterior Exposed Steel: Except where indicated to be primed and painted, Hot Dipped Galvanized per ASTM A123/A123M (latest edition). Galvanizing shall be applied in a manner to provide Class C faying surfaces for slip critical connections. See Structural Steel Coatings section for additional requirements for galvanizing and painting.
- L. Non Shrink Cement-Based Grout: See Section 3

- M. Drilled Anchors: Expansion and adhesive by HILTI, SIMPSON or POWERS/RAWL as indicated on the drawings.

2.02 FABRICATION:

- A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on final shop drawings.
 - 1. Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence which will expedite erection and minimize field handling of materials.
 - 2. Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs and other defects.
- B. Connections: Weld or bolt shop connections, as indicated.
 - 1. Provide field bolted connections, except where welded connections or other connections are indicated.
 - 2. Provide high-strength threaded fasteners for principal bolted connections, except where unfinished bolts are indicated.
- C. High-Strength Bolted Connection: Install high-strength threaded fasteners in accordance with AISC "Specification for Structural Joints using ASTM A 325 or A 490 Bolts". Unless otherwise indicated, all bolted connections are to be tightened to the snug tight condition as defined by AISC.
- D. Welded Construction: Comply with AWS Codes for procedures, appearance and quality of welds, and methods used in correcting welding work.
- E. Holes for Other Work: Provide holes required for securing other work to structural steel framing, and for passage of other work through steel framing members, as shown on final shop drawings.
- F. Cut, drill, or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
- G. Fabricator, Erector and General Contractor shall coordinate safety requirements for the project, in accordance with OSHA Part 1926. Provide all necessary pieces and fabrications as required to safely erect and access the structure for the duration of project construction.
- H. Camber, if any, is indicated on the drawings. Camber indicated is the required camber at time of erection. Contractor shall survey camber prior to placing metal deck.

2.03 STRUCTURAL STEEL COATINGS

- A. Coordinate coating requirements with the Architect, and with Division 9 of the specifications.
- B. To the greatest extent possible, structural steel coatings shall be shop applied.
- C. Galvanizing, priming and painting for structural steel permanently exposed to view shall meet the requirements of Section 10 of the Code of Standard Practice, "Architecturally Exposed Structural Steel".
- D. Provide venting/drainage holes in closed tubular members to be hot-dipped galvanized. Holes shall be provided in a location hidden from view in the final condition and in a manner that will not reduce the strength of the member. Hole locations shall be clearly indicated on the Shop Drawings and are subject to review by the Architect.
- E. Follow manufacturer's installation and safety instructions when applying coatings. Adhere to recoat time recommendations set forth by manufacturer.
- F. General: Shop priming of structural steel is not required for heated, interior steel not exposed to view unless noted otherwise.
- G. Steel which is to receive spray-on fireproofing shall not to be primed or painted, unless specified by the Architect.
- H. Coatings: All exterior steel and/or steel permanently exposed to view shall receive a coating. Unless noted otherwise, refer to Division 9 specifications for products and surface preparation requirements.
- I. Brick masonry loose lintels and relieving angle assemblies, including fasteners, shall be hot dipped galvanized, unless noted otherwise on the Architectural Drawings
- J. Unheated structural steel to be enclosed with architectural finishes, including but not by limitation, canopy members and/or roof pop-up members shall be primed with rust inhibitive alkyd primer, Tnemec Series 349 unless noted otherwise. Follow manufacturer's instructions for surface preparation and application. Substitution shall be equal to the above specified products, and shall be submitted for review.
- K. Steel Embedded in Concrete/Below Grade: Steel which is embedded in concrete, below grade/slab level, or as otherwise indicated on the drawings, shall be field painted with cold-applied asphalt emulsion complying with ASTM D 1187. Paint embedded areas only. Do not paint surfaces which are to be welded until welding is complete.

- L. Field Touch-up: Touch-up all paint and galvanizing damage, including but not by limitation, damage caused during shipping, erection, construction damage, and field welded steel. See Division 9 specifications for additional requirements.

PART 3 EXECUTION

3.01 ERECTION:

- A. General: Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint on surfaces adjacent to field welds.
- B. Erection Procedures: Comply with “Code of Federal Regulations, Part 1926” per the Occupational Safety and Health Administration (OSHA), Department of Labor (Latest Revision).
- C. Surveys: Employ a Registered Land Surveyor to verify elevations of concrete bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Architect and Structural Engineer. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been approved by Structural Engineer of Record. Additional surveys required to verify out-of-alignment work and/or corrective work shall be performed at the contractor’s expense.
- D. Temporary Shoring and Bracing: This is the sole responsibility of the Contractor. Provide temporary shoring and bracing members with connections of sufficient strength to support imposed loads. Remove temporary members and connections when all permanent members are in place, and all final connections are made, including the floor and roof diaphragms. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds. Comply with OSHA Standard referenced previous. Retain the services of a Specialty Structural Engineer (Not the Engineer of Record) to design specialty shoring and bracing.
- E. Anchor Bolts: Furnish anchor bolts and other connectors required for securing structural steel to foundations and other in-place work.
 - 1. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.
 - 2. Welding to anchor bolts for corrective measures is strictly prohibited without prior written approval from the Engineer.
- F. Setting Plates and Base Plates:

1. Furnish templates and other devices as necessary for presetting bolts and other anchors to accurate locations. Refer to division 3 of the project Specifications for anchor bolt installation requirements in concrete.
 2. Clean concrete bearing surfaces of bond-reducing materials. Clean bottom surface of setting and bearing plates.
 3. Set loose and attached base plates for structural members on wedges or other adjusting devices.
 4. Pack non-shrink grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure. For proprietary grout materials, comply with manufacturer's instructions.
- G. Concrete slabs that are part of elevated floors framing systems shall achieve 28-day design strength prior to the application of any superimposed loads such as curtain walls, masonry veneer, mechanical equipment and stairs. Additional testing beyond that specified in division 3 required to verify the concrete strength prior to application of superimposed loads shall be done at the Contractor's expense.
- H. When installing expansion bolts or adhesive anchors, the contractor shall take measures to avoid drilling or cutting any existing reinforcement or damaging adjacent concrete. Holes shall be blown clean with compressed air and/or cleaned per manufacturer's recommendations prior to the installation of anchors.
- I. Field Assembly:
1. Set structural frames accurately to lines and elevations indicated.
 2. Align, adjust, level and plumb members of complete frame in to the tolerances indicated in the AISC Code of Standard Practice and in accordance with OSHA regulations.
 3. Clean bearing surfaces and other surfaces which will be in permanent contact before assembly.
 4. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.
 5. Splice members only where indicated and accepted on shop drawings.
 6. Do not enlarge unfair holes in members by burning or by use of drift pins, except in secondary bracing members. Ream holes that must be enlarged to admit bolts.

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- J. Coat columns, base plates, and brace elements encased in concrete and/or below grade with cold-applied asphalt emulsion. Coordinate coating with concrete work.
- K. Erection bolts: Remove erection bolts. On exposed welded construction and at all braced frame members fill holes with plug welds and grind smooth at exposed surface.
- L. Gas Cutting: Do not use gas cutting torches in field for correcting fabrication errors in primary structural framing. Cutting will be permitted only on secondary members which are not under stress, as accepted by the Engineer of Record. Finish gas-cut sections equal to a sheared appearance when permitted.
- M. Coating Damage: Touch up shop applied paint or galvanizing whenever damaged or bare. See "Coatings" sections for additional requirements.
- N. Field Cut Beam Web Penetrations:
 - 1. Field cut beam web penetrations are not permitted without written approval from the Structural Engineer.
 - 2. Gas cutting torches are not permissible for cutting beam web penetrations without written approval from the Structural Engineer.
 - 3. Beams with field cut beam web penetrations may require reinforcement, subject to the evaluation by the Structural Engineer.
 - 4. The evaluation of field cut web penetrations by the Structural Engineers for Design-Build Subcontractors, including but not by limitation, Mechanical, Electrical, Plumbing and Sprinkler Subcontractors shall be compensated by the General Contractor or Design-Build Subcontractor.
 - 5. The cost of executing field cut web penetrations and the associated beam reinforcement for Design-Build Subcontractors, including but not by limitation, Mechanical, Electrical, Plumbing and Sprinkler Subcontractors shall be paid for by the General Contractor or Design-Build Subcontractor.
 - 6. Field cut beam web penetrations may not be permitted in certain locations, subject to the evaluation by the Structural Engineer.
- O. Welders shall have current evidence of passing and maintaining the AWS D1.1 Qualifications test available in the field.
- P. Welding electrodes, welding process, minimum preheat and interpass temperatures shall be in accordance with AISC and AWS specifications. Any structural steel damaged in welding shall be replaced.
- Q. Field Welded Moment Connections:

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1. Welding of Moment Connections shall meet the requirements of FEMA 353.
2. Backing materials for top and bottom flanges for field welded moment connections shall be removed, backgouge the weld root, and apply a reinforcing fillet weld.
3. Where top flange steel backing materials are utilized, the backing may be left in place. In this case, the backing material shall be welded with a reinforcing fillet weld.

3.02 QUALITY CONTROL:

- A. General: Contractor is responsible for maintaining quality control in the field and for providing a structure that is in strict compliance with the Contract Documents.
 1. Required inspection and testing services are intended to assist the Contractor in complying with the Contract Documents. These specified services, however, do not relieve the Contractor of his responsibility for compliance, nor are they intended to limit the Contractor's quality control efforts in the field.
- B. Testing: Owner shall engage an Independent Testing Agency to inspect all high-strength bolted and welded connections, to perform tests and prepare reports of their findings. All connections must pass these inspections prior to the installation of subsequent work which they support.
 1. Testing agency shall conduct tests and state in each report which specific connections were examined or tested, whether the connections comply with requirements, and specifically state any deviations therefrom.
 2. Contractor shall provide access for testing agency to places where structural steel work is being fabricated, produced or erected so that required inspection and testing can be accomplished. Testing agency may inspect structural steel at plant before shipment. The Engineer, however, reserves the right, at any time before final acceptance, to reject material not complying with specified requirements.
- C. Inspection Requirements (to be performed by the Independent Testing Agency):
 1. Bolted Connections: Inspect all bolted connections in accordance with procedures outlined in the AISC "Specification for Structural Joints using ASTM A325 or A490 Bolts.
 2. Snug Tight Bolted Connections:

- a. The inspector shall monitor the installation of bolts to determine that all plies of connected material have been drawn together and that the selected procedure is used to tighten all bolts.
 - b. If the inspector does not monitor the installation of bolts, he shall visually inspect the connection to determine that all plies of connected material have been drawn together and conduct tests on a sampling connection bolts to determine if they have been tightened to the snug tight condition. The test sample shall consist of 10% of the bolts in the connection, but not less than two bolts, selected at random. If more than 10% of the tested bolts fail the initial inspection, the engineer reserves the right to increase the number of bolts tested.
3. Slip Critical Bolted Connections:
- a. The inspector shall monitor the calibration of torquing equipment and the installation of bolts to determine that all plies of connected material have been drawn together and that the selected procedure is used to tighten all bolts.
 - b. If the inspector does not monitor the calibration or installation procedures, he shall test all bolts in the affected connection using a manual torque wrench to assure that the required pretension has been reached.
4. Field Welded Connections: inspect and test during fabrication of structural steel assemblies, and during erection of structural steel all welded connections in accordance with procedures outline in AWS D1.1. Record types and location of defects found in work. Record work required and performed to correct deficiencies.
- a. Certify welders and conduct inspections and tests as required. Submit welder certifications to Engineer of Record. Perform visual inspection of all welds. Primary and secondary welds, including fillet welds, full penetration welds, and deck puddle welds, applied in the field and/or shop, shall be visually inspected.
 - b. Welds deemed questionable by visual inspection shall receive non-destructive testing. In addition, all partial and full penetration welds, and any other welds indicated on the drawings are to receive non-destructive testing. Non-destructive testing methods include the following:
 1. Radiographic Inspection (RT): ASTM E 94 and ASTM E 142; minimum quality level "2-2T".
 2. Ultrasonic Inspection (UT): ASTM E 164.

3. Magnetic Particle (MT) inspection procedures may be utilized at the inspectors discretion in addition to RT or UT inspection. MT procedures shall not replace RT or UT procedures without permission from the Structural Engineer.
 - c. All welds deemed unacceptable shall be repaired and retested at the Contractor's expense.
- D. Composite Shear Studs/Deformed Bar Anchors:
1. Verify shear stud quantity and arrangement.
 2. Visually inspect stud weld. A weld less than 360 degrees is cause for further testing by bending to 15 degrees per item 2 below. Strike all studs with a 3 pound sledge hammer with moderates force. Studs shall make a ringing sound when struck with the hammer. If a stud or studs breaks free, or fails to make a ringing sound, further testing shall be performed per item 4.
 3. One stud in 100 shall be tested by bending to 15 degrees from vertical, and one stud in 200 shall be tested by bending to 30 degrees from vertical. Single bent studs may be left bent. Failure of stud weld during bend testing is cause for further testing per item 4.
 4. When failure occurs during bend testing, additional bend testing shall be performed on 10 studs to either side of failed stud. Bend studs to 30 degrees from vertical. If failure occurs during additional testing, continue testing in series of 10 studs beyond failed stud until no failure occurs.
 5. Straighten all studs that were bent in multiple stud testing. Replace all studs that fail.
- E. Inspector shall verify that all ferrules are removed when applicable and that metal deck is free of debris prior to concrete placement.
- F. Testing and inspection reports shall be submitted to the Owner, Architect and Engineer within 48 hours of completion of each test or inspection.
- G. Nonconforming Work: Contractor shall be responsible for correcting deficiencies in structural steel work which inspections laboratory test reports have indicated to be not in compliance with requirements. Additional tests and/or surveys shall be performed, at the Contractor's expense, as may be necessary to show compliance of corrected work. Any costs associated with the Engineer's review and disposition of faulty works shall be borne by the Contractor.

END OF SECTION