SECTION 05 50 14

STRUCTURAL METAL FABRICATIONS

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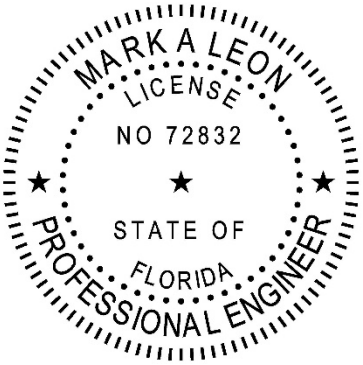
Engineer's Seal



Digital Signature

Mark A. Leon

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MARK A LEON P.E., STATE OF FLORIDA, PROFESSIONAL ENGINEER, LICENSE NO. 72832.

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SECTION 05 50 14

STRUCTURAL METAL FABRICATIONS

PART 1 GENERAL

1.1 REFERENCES

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

ALUMINUM ASSOCIATION (AA)

AA ADM	(2020) Aluminum Design Manual

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA ISO 22849-A12	(2012) Design Recommendations for Bevel Gears
AGMA ISO 23509-A08	(2008) Bevel and Hypoid Gear Geometry
ANSI/AGMA 6001	(2008E; R 2014) Design and Selection of Components for Enclosed Gear Drives

AMERICAN SOCIETY FOR NONDESTRUCTIVE TESTING (ASNT)

ANSI/ASNT CP-189	(2016) ASNT Standard for Qualification and Certification of Nondestructive Testing Personnel (ANSI/ASNT CP-105-2006)

AMERICAN SOCIETY OF MECHANICAL ENGINEERS (ASME)

ASME B4.1	(1967; R 1994; R 2004; R 2009; R 2020) Preferred Limits and Fits for Cylindrical Parts
ASME B46.1	(2020) Surface Texture, Surface Roughness, Waviness and Lay

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M	(2020) Structural Welding Code - Steel
AWS D1.2/D1.2M	(2014; Errata 1 2014; Errata 2 2020) Structural Welding Code - Aluminum
AWS QC1	(2016) Specification for AWS Certification of Welding Inspectors

ASTM INTERNATIONAL (ASTM)

ASTM A123/A123M	(2017) Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
ASTM A380/A380M	(2017) Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
ASTM A780/A780M	(2020) Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings
ASTM B177/B177M	(2011; R 2017) Standard Guide for Engineering Chromium Electroplating
ASTM B766	(1986; R 2015) Standard Specification for Electrodeposited Coatings of Cadmium
ASTM D962	(1981; R 2014) Aluminum Powder and Paste Pigments for Paints
ASTM E94/E94M	(2017) Standard Guide for Radiographic Examination Using Industrial Radiographic Film
ASTM E165/E165M	(2018) Standard Practice for Liquid Penetrant Examination for General Industry
ASTM E446	(2014) Radiographs for Steel Castings Up to 2 In. (51mm) in Thickness
ASTM E709	(2015) Standard Guide for Magnetic Particle Examination
ASTM F3125/F3125M	(2019) Standard Specification for High Strength Structural Bolts and Assemblies, Steel and Alloy Steel, Heat Treated, Inch Dimensions 120 ksi and 150 ksi Minimum Tensile Strength, and Metric Dimensions 830 MPa and 1040 MPa Minimum Tensile Strength

RESEARCH COUNCIL ON STRUCTURAL CONNECTIONS (RCSC)

RCSC S348	(2014; Errata 2015) RCSC Specification for Structural Joints Using High-strength Bolts

1.2 SUBMITTALS

Submit the following in accordance with Section 01 33 00 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings

Welding Procedures

Welding Repair Plan

SD-03 Product Data

Filler Metal

SD-06 Test Reports

Tests, Inspections, and Verifications

SD-07 Certificates

Welding Qualifications

Application Qualification for Steel Studs

Welding of Aluminum

Weld Inspection Log

Certified Welding Inspector

Nondestructive Testing Personnel

1.3 QUALITY ASSURANCE

1.3.1 Detail Drawings

Submit detail drawings for metalwork and machine work, prior to fabrication, include within the detail drawings catalog cuts, templates, fabrication and assembly details and type, grade and class of material as appropriate. Indicate methods of protecting the work during shipping, storage, field assembly, and installation.

1.3.2 Welding Qualifications

Prior to welding, submit certification for each welder stating the type of welding and positions qualified for, the code and procedure qualified under, date qualified, and the firm and individual certifying the qualification tests. If the qualification date of the welder or welding operator is more than 6 months old, accompany the welding operator's qualification certificate with a current certificate by the welder attesting to the fact that he has been engaged in welding since the date of certification, with no break in welding service greater than 6 months.
Conform to all requirements specified in AWS D1.1/D1.1M.

PART 2 PRODUCTS

2.1 FABRICATION

2.1.1 Structural Fabrication

Material must be straight before being laid off or worked. Perform straightening, if necessary, by methods that will not impair the metal. Sharp kinks or bends are cause for rejection of the material. Material with welds will not be accepted except where welding is definitely specified, indicated or otherwise approved. Make bends using approved dies, press brakes or bending rolls. Where heating is required, take precautions to avoid overheating the metal and allow it to cool in a manner that will not impair the original properties of the metal. Proposed flame cutting of material, other than structural steel, is subject to approval and must be indicated on detail drawings. Shearing must be accurate and all portions of the work neatly finished. Make corners square and true unless otherwise shown. Fillet re-entrant cuts to a minimum radius of 3/4 inch unless otherwise approved. Provide finished members free of twists, bends and open joints. Tighten bolts, nuts and screws.

2.1.1.1 Dimensional Tolerances for Structural Work

Measure dimensions using an approved calibrated steel tape of approximately the same temperature as the material being measured. The overall dimensions of an assembled structural unit must be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work. Where tolerances are not specified in other sections of these specifications or shown, an allowable variation of 1/32 inch is permissible in the overall length of component members with both ends milled; component members without milled ends must not deviate from the dimensions shown by more than 1/16 inch for members 30 feet or less in length, and by more than 1/8 inch for members over 30 feet in length.

2.1.1.2 Structural Steel Fabrication

Structural steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Prepare surfaces and edges in accordance with AWS D1.1/D1.1M, Prequalification of WPSs Clause. Where structural steel is not to be welded, chipping or grinding will not be required except as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Chip, grind or machine to sound metal hand-guided cuts which are to be exposed or visible.

2.1.2 Welding

2.1.2.1 Welding of Structural Steel

2.1.2.1.1 Welding Procedures for Structural Steel

Use prequalied welding procedures for structural steel as described in AWS D1.1/D1.1M, Prequalification of WPSs Clause or qualify by tests as prescribed in AWS D1.1/D1.1M, Qualification Clause. For welding procedures qualified by tests, the coupon welding and specimen testing will be witnessed and the test report document signed by the Engineer of Record or the CWI administering the weld test. Approval of any welding procedure does not relieve the Contractor of the

responsibility for producing a finished structure meeting all requirements of these specifications. The Contractor will be directed or authorized to make any changes in previously approved welding procedures that are deemed necessary or desirable by the Engineer of Record

a. Submit a complete schedule of welding procedures for each steel structure to be welded prior to commencing fabrication. Provide the schedule in conformance with the requirements specified in the provisions of AWS D1.1/D1.1M

b. Provide within the schedule detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint. Include in the welding procedures filler metal, preheat, interpass temperature and stress-relief heat treatment requirements. Clearly identify each welding procedure as being prequalified or required to be qualified by tests.

c. Show types and locations of welds designated or in the specifications to receive nondestructive testing in the welding procedures.

2.1.2.1.2 Welding Process

Perform welding of structural steel by an electric arc welding process using a method which excludes the atmosphere from the molten metal and conforms to the applicable provisions of AWS D1.1/D1.1M. Minimize residual stresses, distortion and shrinkage from welding.

2.1.2.1.3 Welding Technique

2.1.2.1.3.1 Filler Metal

Provide the electrode, electrode-flux combination and grade of filler metal conforming to the appropriate AWS specification for the base metal and welding process being used or be as shown where a specific choice of AWS specification allowables is required. Submit filler metal product data. Include the AWS designation of the electrodes to be used in the schedule of welding procedures. Use only low hydrogen electrodes for manual shielded metal-arc welding regardless of the thickness of the steel. Use a controlled temperature storage oven at the job site as prescribed by AWS D1.1/D1.1M, Fabrication Clause to maintain low moisture of low hydrogen electrodes.

2.1.2.1.3.2 Preheat and Interpass Temperature

Perform preheating as required by AWS D1.1/D1.1M, Fabrication Clause or as otherwise specified except that the temperature of the base metal must be at least 70 degrees F. Slowly and uniformly preheat the joint area by approved means to the prescribed temperature, held at that temperature until the welding is completed and then permitted to cool slowly in still air. Maximum interpass temperature not to exceed 450 degrees F.

2.1.2.1.3.3 Stress-Relief Heat Treatment

Where stress relief heat treatment is specified or shown, perform in accordance with the requirements of AWS D1.1/D1.1M, Fabrication Clause unless otherwise authorized or directed.

2.1.2.1.4 Workmanship

Perform welding workmanship in accordance with AWS D1.1/D1.1M, Fabrication Clause and other applicable requirements of these specifications.

2.1.2.1.4.1 Preparation of Base Metal

Prior to welding inspect surfaces to be welded to ensure compliance with AWS D1.1/D1.1M, Fabrication Clause.

2.1.2.1.4.2 Temporary Welds

Make temporary welds, required for fabrication and erection, under the controlled conditions prescribed for permanent work. Make temporary welds using low-hydrogen welding electrodes and by welders qualified for permanent work as specified in these specifications. Conduct preheating for temporary welds as required by AWS D1.1/D1.1M for permanent welds except that the minimum temperature must be 120 degrees F in any case. In making temporary welds, do not strike arcs in other than weld locations. Remove each temporary weld and grind flush with adjacent surfaces after serving its purpose.

2.1.2.1.4.3 Tack Welds

Tack welds that are to be incorporated into the permanent work are to exhibit the same quality requirements as the permanent welds; clean and thoroughly fuse them with permanent welds. Perform preheating as specified above for temporary welds. Provide cascaded ends on multiple-pass tack welds. Remove defective tack welds before permanent welding.

2.1.2.2 Welding of Steel Castings

Remove unsound material from the surfaces of steel castings, to be incorporated into welded connections, by chipping, machining, air-arc gouging or grinding. Do not weld major connections designed for transfer of stresses if the temperature of the casting is lower than 100 degrees F. Preheat castings containing over 0.35 percent carbon or over 0.75 percent manganese to a temperature not to exceed 450 degrees F and conduct welding while the castings are maintained at a temperature above 350 degrees F. Welding is not permitted on castings containing carbon in excess of 0.45 percent except on written authorization. Castings requiring welding repairs after the first annealing and castings involving welding fabrication must be stress-relieved annealed prior to receiving final machining unless otherwise permitted.

2.1.3 Bolted Connections

2.1.3.1 Bolted Structural Steel Connections

Provide bolts, nuts and washers of the type specified or indicated. Equip all nuts with washers except for high strength bolts. Use beveled washers where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the use of high strength bolts is specified or indicated, conform the materials, workmanship and installation to the applicable provisions of ASTM

F3125/F3125M. Install High Strength Bolts ASTM F3125/F3125M Grade A325 or Grade A490 in accordance with the requirements of RCSC S348. All High Strength Bolted Connections are fully pretensioned to the minimum pretension as specified in RCSC S348. Follow the pre-installation verification procedures outlined in RCSC S348. All other bolted connections are snug tight in accordance with RCSC S348.

a. Accurately locate bolt holes, smooth, perpendicular to the member and cylindrical.

b. Drill or subdrill holes for regular bolts and ream in the shop and not more than 1/16 inch larger than the diameter of the bolt.

c. Match-ream or drill holes for fitted bolts in the shop. Remove burrs resulting from reaming. Keep bolt threads entirely outside of the holes. The body diameter of bolts must have tolerances as recommended by ASME B4.1 for the class of fit specified. Place fitted bolts in reamed holes by selective assembly to provide an LN-2 fit.

d. Holes for high strength bolts must not have diameters more than 1/16 inch larger than bolt diameters. If the thickness of the material is not greater than the diameter of the bolts, the holes may be punched. If the thickness of the material is greater than the diameter of the bolts the holes may be drilled full size or subpunched or subdrilled at least 1/8 inch smaller than the diameter of the bolts and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting occurring during assembly cannot distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

2.2 TESTS, INSPECTIONS, AND VERIFICATIONS

Perform material tests and analyses certified by an approved laboratory to demonstrate that materials are in conformity with the specifications. These tests and analyses must be performed and certified at the Contractor's expense. Perform tests, inspections, and verifications conforming to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Conduct tests in the presence of the Engineer of Record if so required. Furnish specimens and samples for additional independent tests and analyses upon request by the Engineer of Record. Properly label specimens and samples and prepare for shipment. Submit certified test reports for materials with all materials delivered to the site.

2.2.1 Nondestructive Testing

When doubt exists as to the soundness of any material part, such part may be subjected to any form of nondestructive testing determined by the Engineer of Record. This may include ultrasonic, magnaflux, dye penetrant, x-ray, gamma ray or any other test that will thoroughly investigate the part in question. Any defects will be cause for rejection; replace and retest rejected parts at the Contractor's expense.

2.2.3 Inspection of Structural Steel Welding

Nondestructive testing of designated welds will be required. Supplemental examination of any joint or coupon cut from any location in any joint may also be required.

2.2.3.1 Visual Examination

All visual inspection will be conducted in accordance with AWS D1.1/D1.1M, by a Certified Welding Inspector. Document this inspection in the Visual Weld Inspection Log. Submit certificates indicating that certified welding inspectors meet the requirements of AWS QC1.

2.2.3.2 Nondestructive Testing

Perform as designated or described in the sections of these specifications, the nondestructive testing of shop and field welds covering the particular items of work. Record final nondestructive testing results in the Weld Inspection Log which identifies final NDT inspection of all welds requiring inspection and submit the log.

2.2.3.2.1 Testing Agency

The nondestructive testing of welds and the evaluation of tests as to the acceptability of the welds must be performed by a testing agency adequately equipped and competent to perform such services or by the Contractor using suitable equipment and qualified personnel. All personnel performing nondestructive testing shall be certified Level II in the method of NDT being utilized in accordance with ANSI/ASNT CP-189. Submit certification for nondestructive testing personnel prior to all testing. In either case, written approval of the examination procedures is required and performance of the examination tests must be done in the presence of the Engineer of Record.

2.2.3.2.2 Examination Procedures

Conform to the following requirements.

2.2.3.2.2.1 Ultrasonic Testing

Examine, evaluate and report ultrasonic testing of welds in conformance to the requirements of AWS D1.1/D1.1M, Inspection Clause, for statically loaded connections. Provide ultrasonic equipment capable of making a permanent record of the test indications. Make a record of each weld tested.

2.2.3.2.2.2 Magnetic Particle Inspection

Conform magnetic particle inspection of welds to the applicable provisions of ASTM E709.

2.2.3.2.2.3 Dye Penetrant Inspection

Perform dye penetrant inspection of welds conforming to the applicable provisions of ASTM E165/E165M.

2.2.3.2.3 Welds to be Subject to Nondestructive Testing

Test 100% of CJP welds using ultrasonic testing per Table 6.2 of AWS D1.1/D1.1M. Randomly test 50%of all PJP and fillet welds or as indicated by magnetic particle or dye penetrant testing.

2.2.4 Welding Repair Plan

Repair defective welds in accordance with AWS D1.1/D1.1M, Fabrication Clause. Remove defective weld metal to sound metal by use of air carbon-arc or oxygen gouging. Thoroughly clean surfaces before welding. Retest welds that have been repaired by the same methods used in the original inspection. Except for the repair of members cut to remove test coupons and found to have acceptable welds costs of repairs and retesting will be borne by the Contractor. Submit welding repair plans for steel, prior to making repairs.

PART 3 EXECUTION

3.1 INSTALLATION

Thoroughly clean all parts to be installed. Remove packing compounds, rust, dirt, grit and other foreign matter. Clean holes and grooves for lubrication. Examine enclosed chambers or passages to make sure that they are free from damaging materials. Where units or items are shipped as assemblies they will be inspected prior to installation. Disassembly, cleaning and lubrication will not be required except where necessary to place the assembly in a clean and properly lubricated condition. Do not use pipe wrenches, cold chisels or other tools likely to cause damage to the surfaces of rods, nuts or other parts used for assembling and tightening parts. Tighten bolts and screws firmly and uniformly but take care not to overstress the threads. When a half nut is used for locking a full nut place the half nut first followed by the full nut. Lubricate threads of all bolts except high strength bolts, nuts and screws with an appropriate lubricant before assembly. Coat threads of corrosion-resisting steel bolts and nuts with an approved antigalling compound. Driving and drifting bolts or keys will not be permitted.

3.1.1 Alignment and Setting

Accurately align each machinery or structural unit by the use of steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other must be true within the respective tolerances required. Set true machines to the elevations shown.

3.2 TESTS

3.2.1 Workmanship

Workmanship must be of the highest grade and in accordance with the best modern practices to conform with the specifications for the item of work being furnished.

3.2.2 Production Welding

Perform production welding conforming to the requirements of AWS D1.1/D1.1M. Studs, on which pre-production testing is to be performed, must be welded in the same general position as required on production items (flat, vertical, overhead or sloping). Test and production stud welding will be subjected to visual examination or inspection. If the reduction of the length of studs becomes less than normal as they are welded, stop welding immediately and do not resume until the cause has been corrected.

3.3 PROTECTION OF FINISHED WORK

3.3.1 Machined Surfaces

Thoroughly clean foreign matter off machined surfaces. Protect all finished surfaces. Oil and wrap unassembled pins and bolts with moisture resistant paper or protect them by other approved means. Wash finished surfaces of ferrous metals to be in bolted contact, with an approved rust inhibitor and coat them with an approved rust resisting compound for temporary protection during fabrication, shipping and storage periods. Paint finished surfaces of metals which will be exposed after installation, except corrosion resisting steel or nonferrous metals as specified in Section 09 97 02 PAINTING: HYDRAULIC STRUCTURES.

3.3.2 Lubrication After Assembly

After assembly fill all lubricating systems with the appropriate lubricant and apply additional lubricant at intervals as required to maintain the equipment in satisfactory condition until acceptance of the work.

-- End of Section --