

SECTION 051200
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The BIDDING REQUIREMENTS, CONTRACT FORMS, AND CONDITIONS OF THE CONTRACT and applicable parts of DIVISION 1 - GENERAL REQUIREMENTS, as listed in Table of Contents, shall be included in and made a part of this Section.

1.2 WORK INCLUDED

- A. Labor, materials, equipment, services and transportation required to complete structural steel work shown on Drawings, as specified herein, or both. Structural steel work is that work defined in AISC "Code of Standard Practice" plus steel work listed below and shown on the structural drawings.
1. Furnishing of anchor bolts, and loose leveling plates.
 2. Furnishing and erection (including bolted and welded connections) of base plates, columns, tubes, channels, struts, beams, hangers, girders, bracing (temporary and permanent), brackets, pipe links, anchors, shear heads, angles, stiffeners, plates, bolsters, clips, structural slide-bearing assemblies, support angles for metal deck, lintels or relieving angles affixed to structure.
 3. Furnishing and installation of openings (unreinforced and reinforced) in structural steel required to accommodate mechanical, plumbing, and electrical work.
 4. Furnishing and installation of non-shrink grout under leveling and base plates.
 5. Furnishing and application of shop paint, including finish coat(s) when required, and field touch-up paint for designated structural steel items.
 6. Furnishing and application of hot-dip galvanizing for masonry lintels, masonry relieving angles, exposed mechanical equipment dunnage beams, and steel so designated on the drawings.
 7. Design of bolted/welded structural connections.
 8. Furnishing and shop-installation of headed shear connectors (excluding shear connectors required for composite beam action) where shown on the drawings.
 9. Furnishing and installation of slide bearing assemblies at expansion joints.
 10. Furnishing and erection of atrium pipe trusses, stepped tubular secondary framing, related supports and slide bearing assemblies.
 11. Furnishing and erection of canopy pipe trusses and related supports.
 12. Furnishing of structural steel items shown in structural drawings required to be built into or form part of work specified under other Sections, to appropriate trade at proper time with complete instructions and templates to facilitate installation. Verify proper installation of same.
 13. Unless specifically excluded, furnishing and installation of any other items of structural steel work indicated on Drawings, specified or obviously needed to make work of this Section complete.
- B. Exclusions from the Contract Documents are not allowed without prior written approval from the Structural Engineer-of-Record. The review process for exclusions shall follow the same general procedures as specified for shop drawing review.

1.3 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section. Other Specification Sections that directly relate to work of this Section include, but are not limited to:
1. Section 014529 Testing Laboratory Services
 2. Section 033000, Cast-in-Place Concrete
 3. Section 053000, Metal Decking
 4. Section 054000, Cold-Formed Metal Framing
 5. Section 055000, Metal Fabrications
 6. Section 061000, Rough Carpentry
 7. Section 078100, Applied Fireproofing
 8. Section 099000, Painting and Coating

1.4 REFERENCES

- A. Except as otherwise specified herein, perform work in accordance with specifications noted below, including latest editions of applicable specifications, codes, and standards cited therein, and latest applicable addenda and supplements. Copies of these items shall be kept available in shop and field.
1. "The Commonwealth of Massachusetts State Building Code", 9th Edition.
 2. "Specification for Structural Steel Buildings", AISC 360-10.
 3. "Seismic Provisions for Structural Steel Buildings", American Institute of Steel Construction (AISC 341-10), including Supplement No. 1 dated 2005.
 4. "Code of Standard Practice for Steel Buildings and Bridges", American Institute for Steel Construction, (AISC) 2010 except as modified herein by deletion of the following sentences: Paragraph 4.4 "These drawings shall be returned to the Fabricator within fourteen (14) calendar days."
 5. "Structural Welding Code - Steel (AWS D1.1-11)", American Welding Society.
 6. "Specification for Structural Joints Using ASTM A325 or A490 Bolts", Research Council on Structural Connections (RCSC) December 31, 2009.
 7. "Painting Manual, Vol. 1, Good Painting Practice" and "Painting Manual, Vol. 2, Systems and Specifications", Steel Structures Painting Council.
 8. American Society for Testing Materials (ASTM) Standards referenced in this Section.
- B. Any material or operation specified by reference to published specifications of manufacturer or published standard shall comply with said specification or standard. In case of conflict between referenced specifications, most stringent requirement shall govern. In case of conflict between referenced specifications and Project Specifications, Project Specifications shall govern.

1.5 SUBSTITUTIONS

- A. Substitutions for member sizes, type(s) of steel, connection details or any other modifications proposed by the General Contractor will be considered by Architect only under following conditions:
1. That request has been made and accepted prior to submission of Shop Drawings.

2. That there is a substantial cost advantage or time advantage to Owner; or that proposed revision is necessary to obtain required materials or methods at proper times to accomplish work in time scheduled.
3. That sufficient sketches, engineering calculations, and other data have been submitted to facilitate checking by Architect, including cost reductions or savings in time to complete work.

1.6 SUBMITTALS

- A. Standard Shop Details and Connection Design Calculations: Submit to Architect prior to submitting detailed Shop Drawings, design calculations and details for connections not shown on the Drawings. Calculations shall be prepared under supervision of registered professional engineer.
- B. Joint Welding Procedures: Submit to Architect joint welding procedures and program of welding sequence (for each component and for welding components together) before any welding is done. After return of submittal, welding procedures and sequences shall be followed without deviation. Architect may require re-qualification of these welding procedures by tests prescribed in AWS "Standard Qualification Procedure".
- C. Quality Control Manual: Submit to Architect, prior to start of fabrication, description of field and plant inspection procedures including titles of responsible personnel, methods and equipment for non-destructive testing of specific typical joints, documentation of inspection results, and procedures for repairing or disposing of nonconforming materials. Results of tests during the course of work shall, upon request by Architect, be made available for review by Architect and/or Testing Agency.
- D. Methods of Erection: Submit to Architect, in accordance with requirements of Contract Documents, prior to starting work, description of methods, sequence of erection, and type of equipment proposed for use in erecting structural steel work. Provide construction loads imposed on permanent structure.
 1. Architect's review is only for effects of methods on permanent structure. This submission shall not relieve the General Contractor of his responsibility for providing proper methods, equipment, workmanship, and safety precautions.
- E. Shop Drawings: Submit to Architect detailed Shop Drawings, including erection drawings, schedules and index sheets showing: grades of steel; identification mark of members; orientation and relation of members to appropriate grid lines; setting elevations for column bases; framing to support metal deck; location and size of openings, slots, and holes; requirements, such as punched or drilled holes, for attachment of other materials or parts of construction; type, size, and location of shop and field connections; type, size, and extent of welds; joint welding procedures; welding sequences (use welding symbols adopted by American Welding Society); cleaning requirements prior to painting; type and dry thickness of paint. Members to be galvanized shall be so noted on shop drawings.
 1. Architect's checking is a review for conformance with the design concept of the project and compliance with the information given in the Contract Documents. The General Contractor is responsible for: confirming and correlating all quantities and dimensions; selecting fabrication processes and techniques of construction coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

2. Do not proceed with fabrication of material or performance of work until corresponding item on Shop Drawing has been reviewed by Architect.
 3. All submittals shall be prepared with an action stamp which includes Structural Engineer's name and date-received and date-returned box.
- F. Samples: Submit to Architect, upon request by Architect, samples and/or descriptive literature of materials, products and methods.
1. Do not proceed with fabrication of material/product or performance of work until Sample has been approved by Architect.
- G. Submit to the Architect complete shop details (keyed to erection layouts) and technical data for all structural bearings specified or shown.
- H. Submit to the Architect drawings and directions for the installation of anchor bolts, high strength bolts, direct tension indicator washers, torque control snap-off bolts, or items to be installed by others. Verify proper installation of same.
- I. Items requiring field measuring shall have all dimensions verified in the field before fabrication. Field dimensions shall be shown on the Shop Drawings and shall be noted as having been verified in the field.

1.7 QUALITY ASSURANCE

- A. Fabricator Qualifications: Fabricator must be experienced in fabrication of structural steel for projects of similar size and difficulty; shall have particular experience in fabrication of large, welded, built-up sections; subject to approval of Architect, Structural Engineer and Owner; must have current CBD AISC Quality Certification.
- B. Steel Detailer Qualifications: Steel detailers must be experienced in detailing structural steel for projects of similar size and complexity. Steel detailer must be experienced in detailing structural steel in accordance with AISC seismic provisions for structural steel building.
- C. Mill Test Certification for Structural Steel: Submit to Architect, prior to delivery of structural steel to job site, certified mill test reports of structural steel (including names and locations of mills and shops, and analyses of chemical and physical properties), properly correlated to structural steel to be used in this project. This submittal is for information and file record.
- D. Mill Test Certifications for Connection Material: Submit to Architect, prior to delivery of structural steel to job site, certified mill test reports of bolts, nuts and washers (including names and locations of mills and shops, and analyses of chemical and physical properties), properly correlated to connections on this project. Submit manufacturer's certifications for filler metal for welding. This submittal is for information and file record.
- E. Painting Certification: Submit to Architect certification stating that requirements pertaining to pre-paint cleaning and painting of steel have been performed in accordance with Contract Documents. This submittal is for information and file record.
- F. Galvanizing Certification: Submit to Architect a copy of certification stating that requirements pertaining to pre-galvanizing cleaning and galvanizing of steel have been performed in accordance with Contract Documents. This submittal is for information and file record.

- G. Corrective Work: Submit to Architect drawings showing details of proposed corrective work prior to performing corrective work.
- H. Affidavit: Submit to Architect, on request by Architect, manufacturer's and/or fabricator's and/or erector's affidavit stating that material or product provided complies with Contract Documents.
- I. Maintain records of shop and field welding procedures and records of welders employed, date of qualification and identification symbol or mark. Maintain records for each impact wrench used in shop and field, showing dates, sizes of bolts tested and the corresponding torque values. Certified copies of the records shall be made available to the General Contractor, Architect and Owner's testing laboratory.
- J. Pre-Fabrication Conference: conduct a conference with representatives of the General Contractor, Fabricator, Detailer, Erector, Engineer, Architect and Owner's Testing Laboratory at the project site prior to commencing shop drawing preparation to confirm erection methods, construction sequences, connection detail types, submission procedures, submission schedule and testing and inspection requirements.
- K. Pre-Erection Conference: Conduct a conference with a representative of the General Contractor, Fabricator, Detailer, Erector, Engineer, Architect and Owner's Testing laboratory at the project site prior to commencing erection to verify site conditions, methods and sequencing.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide positive identification for each steel type and tensile strength classification, except A36 steel, by a uniform marking system on each piece. All steel shall be newly rolled steel.

2.2 MATERIALS

- A. High strength low alloy steel: ASTM A992, or ASTM A588, of grades and to provide yield strengths shown on the drawings. Use A588 or A992 modified for plates over 1½ inch thick where Fy 50 ksi is required.
- B. Carbon steel: shapes, plate and bar shapes, ASTM A36. Rectangular and Square HSS (Tubes), ASTM A500 Grade B (Fy = 46 ksi); Round HSS (pipe), ASTM A500, Grade B (Fy = 42 ksi).
- C. Requirements for Heavy Tension Members: All structural shapes in ASTM A6, Groups 4 and 5 (W14 series W14x233 and larger and W12 series W12x201 and larger) and plates exceeding 2 inches thick subject to primary tensile stresses due to tension or flexure, such as truss members, plate girder flanges, and braced frame columns, and that are spliced using complete-joint penetration welds shall additionally conform to the following requirements:
 - 1. Steel shall be fine-grained killed steel.
 - 2. Charpy V-Notch impact tests shall be performed according to ASTM A673 with the following provisions and exceptions:
 - a. The frequency of testing shall be (P) as prescribed in the specification.
 - b. The test temperature shall be 70°F.

- c. The absorbed energy shall be 20 ft.-lbs.
 - d. The center longitudinal axis of the specimens shall be located as near as practical to midway between the inner flange surface and the center of the flange thickness at the intersection with the web mid-thickness.
 - e. Tests shall be conducted by the producer on material selected from a location representing the top of each ingot or part of an ingot used to produce the product represented by these tests.
- D. Anchor Bolts: ASTM F1554, Grade 36, unless noted otherwise.
- E. High Strength Bolts: ASTM A325 or ASTM A490 with ASTM A563, Heavy Hex Style Nuts, conforming to Table 2.1 of "Specification for Structural Joints Using High-Strength Bolts", 2009 RCSC, and compatible washers. Bolts shall be cold-forged with rolled threads. Bolts with Torque Control snap-off ends may be used.
- F. Direct Tension Indicating Compressible Washers: ASTM F959-85, steel alloy washer with 5 to 6 circular protrusions on one side and selected to match bolt strength.
- G. Filler Metal for Welding: E70XX low hydrogen as per Table J2.3 of LRFD Specification or as per Table J2.5 of the Allowable Stress Specification of AISC.
- H. Headed Studs: ASTM A108, Grades 1010, 1015, 1017, or 1020, minimum yield point of 50,000 psi, and minimum tensile strength of 60,000 psi.
- I. Structural Steel Protective Coatings:
1. Structural Steel Primer Paint: "Tnemec Series 10", "Dupont 761", or P&L Noxide 90".
 2. Spray fireproofing compatible primer paint: Tnemec Perime Prime series 394.
 3. Structural Steel Finish Paints: See Paragraph 3.5B below.
 4. Galvanizing: Hot dip galvanize steel so designated herein and on the drawings and after fabrication in compliance with ASTM A-123. Hot-dip galvanized steel shall be inspected for compliance with ASTM A-123 and shall be marked with a stamp that indicates the name of the galvanizer, the ASTM Number, and the ounces of zinc per square foot of surface. A notarized Certificate of Compliance with all of the above shall be required from the galvanizer.
- J. Coating for Finished Bearing Surfaces (e.g., columns): "Magnafilm 1043" by Magnus Chemical Co., Garwood, N.J.; "M-2658, Blue Lacquer" by U.S. Steel Corp., Pittsburgh, PA or approved equivalent.
- K. Slide Bearings: Slide bearings shall comprise of sliding surfaces of 3/32 inch thick virgin tetrafluoroethylene polymer reinforced with glass fiber aggregate and bonded to 10 gage stainless steel backing plates. Bearings shall have a safe working load capacity of 2000 psi at 60 degrees F. and coefficient of friction not exceeding 0.1.
- L. Bedding mortar for bearing and base plates:
1. Non-Shrink: CRD-C 621, factory pre-mixed grout, Type D, non-metallic, shall be one of the following or an approved equivalent:
 - a. "Masterflow 713"; Master Builders.
 - b. "SonogROUT"; Sonneborn-Contech.
 - c. "Euco-NS"; Euclid Chemical Co.

- d. "Five Star Grout"; U.S. Grout Corp.

- M. Expansion Bolts: 3/4" diameter stainless steel with ultimate capacities in 4000 psi concrete of 16,000 lbs. in shear and 16,000 lbs. in tension; minimum embedment of 6"; shall be one of the following or an approved equivalent:
 - 1. "Parabolt", ISM Corp.
 - 2. "Kwik Bolt II", Hilti Corp.
 - 3. "Red Head Trubolt Wedge Anchor", ITW Ramset/Redhead.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine work prepared by other trades to receive work of this Section and report any defects affecting installation to the General Contractor for correction. Commencement of work will be construed as complete acceptance of preparatory work by others.

3.2 ARCHITECTURALLY EXPOSED STRUCTURAL STEEL

- A. Fabricate and erect members or components designated as AESS on the drawings in accordance with Section 10 of the AISC Code of Standard Practice.

3.3 HANDLING AND STORAGE

- A. Handle and stack materials carefully to prevent deformation or damage. Use fabric slings to transport finished, prepainted members. Store structural steel carefully on substantial timbers and blocking, so arranged that steel will be free from earth and properly drained, preventing any spattering with dirt or accumulation of water in or about steel. Take care to prevent damage to any shop painted surfaces and to prevent accumulation of mud, dirt, or other foreign matter on steel. Any accumulation shall be completely removed prior to erection.

- B. All bolts shall be kept in dry storage until needed for installation. A325 bolts 1-1/8" and 1-1/4" and A490 bolts 1" and over must first have Johnson's Stick Wax #140 applied to their threads before being assembled in work. If bolts have been left out and have become rusty before use, they shall be rejected and shall not be used until they have been cleaned and waxed with Johnson's Stick Wax.

3.4 SHOP FABRICATION

- A. Except as otherwise indicated on Drawings or specified herein, fabricate structural steel in accordance with References in this Section.

- B. Permissible tolerances for steel members shall conform to ASTM A6. The as-fabricated tolerances shall conform to the cited AISC Specifications, AISC Code and the AWS Code, except where closer tolerances and straightness of members are required for fitting of the work in fabrication or erection.

- C. Provision for attachment of other materials: Punch and drill steel for attachment of other materials indicated on Drawings or noted in Specifications to be attached to steel.

- D. The General Contractor shall design and detail all connections required to resist the loads and reactions shown on the drawings and as specified. Fabrication and erection details shall supplement and be consistent with details shown on the drawings. Do not use one-sided or other eccentric connections, except in isolated cases where approval of Architect is obtained.
- E. Welding:
1. Provide quality control and qualification of welders and welding procedures and operations as specified under "Inspection and Testing" in this Section.
 2. Shop Welding Process: Use shielded metal-arc, submerged arc, gas metal-arc, and flux cored-arc, or other process approved by Architect.
 3. Groove Welds: Provide complete penetration unless otherwise noted on Drawings.
 4. Fillet Welds: Where weld symbol is not shown or welds are not dimensioned, provide continuous fillet welds all around and on both sides as appropriate. Minimum dimension shall be as shown in Table J2.5 of LRFD Specification or Table J2.4 of Allowable Stress Specification of AISC.
 5. Base metal shall be checked by the General Contractor to insure absence of laminations or other defects. Welds shall be sound throughout and have no cracks.
 6. Where structural joints are required to be welded, details of joints, technique of welding employed, appearance and quality of welds made, and methods used in correcting defective work shall conform to applicable requirements noted under References in this Section.
 7. Prepare joint welding procedures and program of welding sequence (for each component and for welding jointing components to each other) and submit to Architect for approval before any welding is done. After approval, welding procedures and sequences shall be followed without deviation unless specific approval for change is obtained from Architect. Architect may require re-qualifications of these welding procedures by tests prescribed in AWS "Standard Qualification Procedures".
 8. Each welder working on the project shall be assigned an identification symbol or mark. Each welder shall mark or stamp his identification symbol at each weldment completed, whether in shop or field.
- F. Manual oxygen cutting shall be done only with a mechanically guided torch, except as permitted below.
1. Gas cut edges which are not welded and will be free of substantial stresses, as determined by the Architect, may be cut manually with an unguided torch provided that specified AISC edge distances to holes are maintained.
 2. Gas cut edges which will be subjected to substantial stress (over one-half the allowable stress), as determined by the Architect, or which are to be welded may be cut manually with an unguided torch to a line within 1/8 inch of the finished dimension, with final removal of material completed by chipping or grinding to produce a surface quality equal to that of the base metal edges.
- G. Openings in Structural Steel.
1. Cutting of openings differing from or in addition to those shown on approved shop drawings will not be permitted without written approval of Architect.
- H. Corrective Work: Structural steel elements having fabrication errors and/or which do not satisfy tolerance limits shall not be incorporated in finished work. Such elements may be corrected if permitted by Architect and/or Testing Agency. Submit to Architect drawings

showing details of proposed corrective work. These drawings shall be approved by Architect prior to performing corrective work. Corrective work shall be performed in accordance with requirements of Contract Documents. Corrective work and any retesting which may be required shall be at the General Contractor's expense.

1. Identification: Structural steel members shall have an assigned position and identification mark or symbol, clearly indicated on each piece near one end. Marks shall correspond to that given on Shop Drawings and erection drawings related to specific members.

3.5 SHOP PAINTING

- A. General: Verify that products listed below meet regulations of jurisdiction for Volatile Organic Compounds (VOC) emissions. Notify Architect if listed products do not comply and submit information about equivalent products that do comply.
- B. Unexposed Steel:
 1. Except as otherwise indicated on Drawings or specified herein, paint structural steel work in accordance with Reference Specifications in this Section.
 2. Steel to be painted:
 - a. Clean steel surfaces in accordance with SSPC-SP2, Hand Tool Cleaning.
 - b. Unless specifically excluded or modified, apply one shop coat of structural steel primer paint to steel. See Materials above for primer type.
 - c. Apply paint to surfaces requiring paint only to within two inches of any field weld or high strength bolted friction-type connection. If for any reason surface to be field welded or bolted is painted, remove such paint completely to within limits before field welding or bolting.
 3. Steel to be left unpainted:
 - a. Surfaces to receive metal deck and/or shear connectors fastened by welding.
 - b. Contact surfaces of high strength bolted connections.
 - c. Finished Bearing Surfaces and Surfaces to be welded in field: Protect surfaces (e.g., bearing surfaces of columns and column base plates) against corrosion by use of rust-inhibiting coating that can be easily removed prior to erection or which has characteristics that make removal unnecessary prior to erection.
 - d. Surfaces to receive sprayed-on fireproofing.
 - e. Member areas to be embedded in concrete or mortar.
 4. Shop Coat Application:
 - a. After steel has been properly prepared as specified above, apply structural steel primer paint to dry steel surfaces by brush, spray, or roller, assuring no running or sagging in accordance with manufacturer's directions as approved by Architect.
 - b. Apply 2.0 to 3.0 d.m.t. of shop primer.
 - c. Inspection of shop painting - as specified under "Inspection, Testing and Quality Control" in this Section.
- C. Exposed Steel (Pre-finished)

1. Except as otherwise indicated on Drawings or specified herein, paint structural steel work in accordance with Reference specification in this Section.
2. Surface preparation:
 - a. Exposed steel within protected environment, such as atrium pipe trusses and exposed framing members - SSPC SP-6, Commercial Blast Cleaning.
 - b. Exposed steel subject to corrosive solutions or exterior atmosphere, such as water storage tank columns, shear heads, garage ramp beams, loading dock framing, cooling tower dunnage, relieving angles -- SSPC-SP6 - Commercial Blast Cleaning; or Galvanizing.
3. Primer Application - SPRAY ONLY
 - a. Exposed steel within protected environment: single package epoxy urethane zinc-rich material such as "Tnemec 394 PerimePrime", "Dupont 62ZF" (80% zinc-rich), "Keeler & Long Methane Zinc Rich" or an approved performance equal at 3.0 to 3.5 mils d.f.t. Primer shall be rated Class B, and compatible with 25 pcf and higher spray-on fireproofing.
 - b. Exposed steel subject to corrosive solutions or exterior atmosphere:
 - i) SP-6 preparation: primer such as "Tnemec 27 Typoxy", "Dupont 25P", "K & L 3700", or an approved performance equal; at 3.0 to 4.0 mils d.f.t.
 - ii) Factory-Applied Primer over Galvanized Steel: Provide factory-applied prime coat, certified OTC/VOC compliant less than 2.8 lbs/gal. and conforming to EPA and local requirements. Apply primer within 12 hours after galvanizing at the same galvanizer's plant in a controlled environment meeting applicable environmental regulations and as recommended by the primer coating manufacturer. Primer coat shall exhibit a rugosity (smoothness) not greater than 4 rug (16-20 microns of variation) when measured by a profilometer over a 1 inch straight line on the surface of architectural and structural elements that are less than 24 pounds per running foot. Blast cleaning of the surface is unacceptable for surface preparation. Primer shall have a minimum two year re-coat window for application of finish coat. Coatings must meet or exceed the following performance criteria as stipulated by the coatings manufacturer:
 - a) Abrasion Resistance: ASTM D4060 (CS17 Wheel, 1,000 grams load). 1kg load, 200 mg loss.
 - b) Adhesion: ASTM D4541, 1050 psi.
 - c) Corrosion Weathering: ASTM D5894, 13 cycles, 4,368 hours; rating 10 per ASTM D714 for blistering and rating 7 per ASM D610 for rusting.
 - d) Direct Impact Resistance: ASTM D2794, 160 in. lbs.
 - e) Flexibility: Method: ASTM D522, 180 degree bend, 1 inch mandrel, passes.
 - f) Pencil Hardness: ASTM D3363, 3B.
 - g) Moisture Condensation Resistance: ASTM D4585, 100 degrees F, 2000 hours; passes, no cracking or delamination.
 - h) Dry Heat Resistance: Method: ASTM D2485, 250 degrees F.
 - i) Warranty: Provide galvanizer's warranty that materials will be free from 10 percent or more visible rust for a period of 20 years.
4. Finish Coat - SPRAY ONLY

- a. Exposed steel within protected environment:
 - i) First Coat: Epoxy-polyamide coating such as "Tnemec 27 Typoxy", "Dupont 25P", "Keeler & Long 3500 Series", or an approved performance equal at 4.0 to 6.0 mils d.f.t.
 - ii) Second Coat: See Related Work sections.
- b. Exposed steel subject to corrosive solutions or exterior atmosphere: Epoxy coating such as "Tnemec 27 Typoxy" or an approved performance equal at 10 to 12 mils d.f.t.; or "Duncan Colorgalv" where galvanized base is used.
- c. Factory-applied Architectural Finish over Galvanized and Primed Steel: Provide factory-applied architectural coating over hot-dip galvanized and factory-primed steel matching approved samples.
 - i) Finish coat shall be factory-applied color-pigmented architectural finish. Apply finish coating at the galvanizer's plant over primed steel (as above), in a controlled environment meeting applicable environmental regulations and as recommended by the finish coating manufacturer. Finish coat shall exhibit a rugosity (smoothness) not greater than 4 rug (16-20 microns of variation) when measured by a profilometer over a 1 inch straight line on the surface of architectural and structural elements that are less than 24 pounds per running foot.
 - ii) Coatings shall be certified OTC/VOC compliant and conform to applicable regulations and EPA standards.
 - iii) Apply the galvanizing, primer, and coating within the same facility and provide single-source responsibility for galvanizing, priming and finish coating.
 - iv) Clean galvanized surface to create an acceptable profile for coatings. Galvanizer shall certify that performance will be met without blast-cleaning, and coating will be applied within 12 hours of galvanizing at the galvanizer's plant. If blasted, galvanizer shall certify that rugosity standards are met.
 - v) Topcoat shall meet or exceed the following performance criteria:
 - a) Abrasion Resistance per ASTM D4060, CS17 Wheel, 1,000 Cycles 1 kg Load: 87.1 mg loss.
 - b) Adhesion per ASTM D4541: 1050 psi.
 - c) Direct Impact Resistance per ASTM D2794: >28 in. pounds.
 - d) Indirect Impact Resistance per ASTM D2794: 12-14 in. pounds.
 - e) Dry Heat Resistance per ASTM D2485: 200E F.
 - f) Salt Fog Resistance per ASTM B117 9,000 Hours: Rating 10 per ASTM D714 for blistering.
 - g) Flexibility per ASTM D522, 180E Bend, 1/8 in. Mandrel: Passes.
 - h) Pencil Hardness per ASTM D3363: 2H.
 - i) Moisture Condensation Resistance per ASTM D4585, 100E F, 1000 Hours: No blistering or delamination Xenon Arc Test per ASTM D4798: Pass 300 hours.
5. Surfaces inaccessible to blast cleaning after assembly shall be blast cleaned and coated before assembly. Zinc-rich primers may be applied to friction type connections in accordance with AISC Specifications.
6. The General Contractor shall include complete details and description of coating operations on shop drawings for approval of the Architect.
7. A pre-production conference shall be arranged by the General Contractor with the Architect, fabricator and representative of the paint manufacturer prior to work.

- D. Notification: Notify Testing Agency five (5) days prior to shipment of any structural steel so paint inspection can be made. At these inspections dry mil thickness of paint film will be checked. Steel containing mill scale that can easily be removed with blade of pocket knife will be subject to re-cleaning and re-painting at no expense to the Owner.

3.6 GALVANIZING

- A. Hot-dip Galvanizing: For steel exposed to the elements, weather or corrosive environments, and other steel indicated to be galvanized, provide coating for iron and steel fabrications applied by the hot-dip process.
 - 1. Comply with ASTM A123 for fabricated products and ASTM A153 for hardware.
 - 2. Provide thickness of galvanizing specified in referenced standards.
 - 3. Galvanizing bath shall contain special high-grade zinc and other earthly materials.
 - 4. Fill vent holes after galvanizing, if applicable, and grind smooth.
- B. Certificate of Compliance for Shop Drawing Review by Galvanizer: If requested, submit galvanizer's certification that shop drawings for metal fabrications to receive metal coatings have been reviewed and that fabrications are acceptable to galvanizer for proper application of galvanizing and metal coatings. All drawings should be signed by the galvanizer to indicate acceptance of design for galvanizing.
- C. Galvanizer shall supply a written warranty stating that the galvanized material shall remain free from 5% or more visible rust for a period of twenty years.
- D. Coordination between Fabricator and Galvanizer: Prior to fabrication and final submittal of shop drawings to Architect, direct fabricators to submit shop drawings to the galvanizer for all metal fabrications to receive factory-applied metal coatings. Direct galvanizer to review fabricator's shop drawings for suitability of materials for galvanizing and coatings and coordinate any required modifications to fabrication required to be performed by the fabricator.
- E. Rugosity: Factory-applied metal coatings shall exhibit a rugosity (smoothness) not greater than 4 rug (16-20 microns of variation) when measured by a profilometer over a 1 inch straight line on the surface of architectural and structural elements that are less than 24 pounds per running foot. Profilometer shall be capable of operating in 1 micron increments. Surface blasting prior to application of factory-applied post galvanizing wet coatings will produce a high rugosity and not be acceptable.

3.7 HEADED STUD WELDING REQUIREMENTS

- A. Testing Agency shall conduct test welding procedure for welding of headed studs.
- B. Headed studs shall be applied in accordance with manufacturer's printed instructions. Use only personnel and equipment authorized by manufacturer.
- C. Check headed studs for indications of insufficient and improper weld:
 - 1. Less than 360 degree fillet for headed studs.
 - 2. Burn-off (reduction in length after welding) less than 1/8 inch.
 - 3. Cold appearance of weld.

- D. If, after welding of any headed stud, visual inspection indicates any imperfections listed above or any other questionable appearance, such shear connector shall be struck hard with three-pound hammer and bent 15 degrees off perpendicular to beam and toward nearest end of beam. Headed studs meeting this test shall be considered acceptable and left in this position. Headed studs failing under this test shall be replaced.
- E. Personnel welding headed studs shall be qualified using elements of above procedure, prior to any production welding of headed studs.

3.8 FIELD ERECTION

- A. Except as otherwise indicated on Drawings or specified herein, erect structural steel in accordance with Reference Specifications in this Section.
- B. Surveys: Employ an engineer or surveyor for accurate erection of structural steel. Check elevations of concrete and masonry bearing surfaces, and locations of anchor bolts and similar devices, before erection work proceeds, and report discrepancies to Architect. Do not proceed with erection until corrections have been made, or until compensating adjustments to structural steel work have been agreed upon with Architect. Establish required leveling and plumbing references with respect to expected service temperatures inside the building; compensate as required for difference between service temperature and erection temperature.
- C. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds. Loads imposed during construction shall be determined by an Engineer employed by the General Contractor.
- D. Field Connections: Beams shall have framed connections using 3/4 inch diameter (min.) high strength bolts in accordance with requirements of AISC "Manual of Steel Construction" and Contract Documents. Do not use one-sided or other eccentric connections, except in isolated cases where approval of Architect is obtained. Snug all nuts before applying final torque to any one.

1. High Strength Steel Bolts

- a. Perform installation by using pneumatic powered impact wrenches with sufficient capacity and adequate supply of compressed air. On large bolts (1-1/8" and 1 1/4" A325 and 1" or over A490) wrenches used shall be equivalent in capacity to a Chicago Pneumatic 6120. Air pressure shall be maintained at 100 psi at the wrench.
- b. Perform installation in accordance with turn-of-nut method outlined in RCSC "Specification for Structural Joints Using ASTM A325 or A490 Bolts", with modifications noted below.

Use hardened washer under bolt head or nut, whichever is turned in tightening, unless oversize holes have been approved which require such washer under both head and nut. Use not more than two washers.

Qualification of high strength bolting procedures and operations shall be as specified under "Inspection, Testing and Quality Control", in this Section.

- Refer to this bolting installation method as "Modified Turn-of-nut Tightening Method".
- c. In lieu of "modified turn-of-nut" method, direct tension indicator washers or snap-off TC bolts may be used at the General Contractor's option provided it can be demonstrated by an accurate direct measurement procedure that bolt has been properly tensioned; written approval by Architect is required.
 - i) If tension indicator washers are used, place protrusions against bolt head and tighten the nut. Do not tighten at head. All plies must first be brought into firm contact by partially compressing the direct tension indicator bumps. Tightening shall commence from the most rigid part of the connection to its free edges. The part not being turned must be held by a spud wrench, as the bolt must not be allowed to spin.
 - ii) If snap-off bolts are used for friction type connections, snug tight all bolts in connections before proceeding to apply final snap-off torque.
 - d. Make joints without use of erection bolts; high strength bolts required for joint shall serve that purpose.
 - e. Correct poor matching of holes by drilling to next larger size and using larger size bolt, if approved by Architect. Welding or enlarging with drift pins shall not be permitted without Architect's approval.
 - f. If top flange plates are used at girder moment connections, bolts at top flange plate shall be oriented nut-end down.
- 2 Field Welding: Execute in accordance with requirements under "SHOP FABRICATION" in this Section, excepting those requirements which apply to shop conditions only.
- E. Errors in shop fabrication or deformations resulting from handling and/or transportation that prevent proper assembly and fitting of parts shall be reported immediately to Architect for approval of method of correction. Approved corrections shall be made at the General Contractor's expense.
 - F. Furnish templates and anchor bolts and instructions for setting of anchor bolts and other items to be embedded in cast-in-place concrete, in ample time so that this work will not be delayed.
 - G. Setting Base and Bearing Plates: Clean bearing surfaces of concrete and masonry and the bottom of the plates. Set plates level to correct elevations and support temporarily on steel wedges, shims, leveling devices, or as shown on Drawings, until corresponding supported member has been positioned, plumbed and anchor-bolted. Entire area under plates shall then be packed solidly with non-shrink bedding grout. Leave protruding leveling devices in place until after grout has attained required strength, and then cut off flush with top or edges of base plates, or both, except as otherwise noted.
 - H. Align, level, and adjust members accurately prior to final fastening. Fasten compression member splices only after abutting surfaces have been brought completely into contact. Splice members only where shown on the Drawings.
 - I. Top flanges of beams to receive shear connectors, shall be free of paint, water, dirt, rust, or any other material detrimental to welding.
 - J. Openings in structural steel required in field:

1. Make no openings without the specific written approval of the Architect. All re-entrant corners shall be shaped notch-free to a radius of at least 1/2 inch at blocks, copes, cuts and openings.
2. Openings in structural steel shall be cut and/or reinforced only by structural steel Contractor, and only with specific prior written approval of the Architect.
3. Field Oxygen Cutting: Not to be performed without written consent of Architect. Once approval is obtained, execute in accordance with requirements under "FABRICATION" in this Section.

3.9 FIELD PAINTING

A. Field Coat application:

1. Use same type of paint as used for shop coat.
2. After erection, touch-up field welds and connections and other surfaces required to be painted. Do not paint connections until after inspection and approval of Testing Agency.
3. Do not paint when ambient temperature is below 37 degrees F. or when conditions differ from paint manufacturer's recommendations, as approved by Architect.
4. Touch up damaged galvanizing with zinc-rich paint in accordance with ASTM A780.

3.10 INSPECTION AND TESTING

- A. Inspection and testing of structural steel fabrication and erection will be performed by an independent Testing Agency, under a separate contract with the Owner. Materials and workmanship shall be subjected to inspection and testing in mill, shop and/or field by Testing Agency and shall be subjected to periodic observation by the Architect. Such inspection and testing shall not relieve the General Contractor of his responsibility to provide his own inspection, testing, and quality control as necessary to furnish materials and workmanship in accordance with requirements of Contract Documents.
- B. Requirements of this Section are generally written for purpose of securing best workmanship and end result. Certain deviations may be desirable under certain project conditions, however, and may be allowed after examination by and upon written approval of Architect. Any such approved deviation shall not be construed as waiver of requirements of Specifications.
- C. The General Contractor shall maintain his own inspection and quality control of shop and field work. Quality control and inspection of welding work shall consist of supervision by the General Contractor's own welding inspector using non-destructive spot testing, at rate of at least one test per 50 linear feet of weld by each welder, except that full penetration welds shall be tested 100 percent by the ultrasonic method. Results of such tests shall be provided to Architect and/or Testing Agency when requested.
- D. Notify Architect and Testing Agency prior to start of any fabrication, erection, or other phases of work so as to afford them reasonable opportunity to visit the site. Such notification shall be made at least 36 hours in advance.
- E. Facilitate inspection and testing by Testing Agency. The General Contractor shall, at his own expense, furnish Testing Agency, upon request, with:

1. Complete sets of approved Shop Drawings and corrective work procedures at fabricating shop(s) and in field.
 2. Cutting lists, order lists, material bills, shipping lists, and mill reports.
 3. Information as to time and place of all rollings and shipments of material to shops and field.
 4. Representative sample pieces requested for testing.
 5. Free and safe access and assistance for testing materials, and proper facilities for inspection of work, in mill, shop and field.
- F. Do not remove any marks or tags applied by Testing Agency identifying rejected work.
- G. Any work found deficient shall be corrected or replaced in accordance with these specifications. Deficient welds shall be cut out to sound material and rewelded. Deficient assemblies shall be taken apart, corrected and reassembled, using new materials as required. A490 bolts shall not be reused. A325 bolts may be retightened once only.
- H. Structural steel work which has been rejected by Architect and/or Testing Agency in mill, shop, or field, shall be corrected by the General Contractor without delay and at no expense to the Owner. Additional tests shall be performed at the General Contractor's expense to confirm compliance of corrected work.
- I. The acceptance of steel work at the shop shall not prevent its final rejection at the job site, or even after it has been erected, if it is found to be defective in any way.
- J. Qualifications for Welding Work:
1. Qualify welding processes and welding operators in accordance with the latest edition AWS "Standard Qualification Procedure".
 2. Provide certificates of welders to be employed in the work showing that they have satisfactorily passed AWS qualification tests for the specific types of welds they will be doing; where certification dates are older than 12 months before start of welding work, certify that affected welder(s) have been continuously employed doing the type(s) of welds since certification.
- K. Sampling and testing for quality assurance of bolted and welded work by the Owner's testing agency may include the following, as directed by the Architect.
1. Shop and Field Bolted Connections:
 - a. Inspect in accordance with RCSC specifications. Calibrate wrenches periodically.
 - b. A minimum of two bolts in each connection shall be tested. If tension indicating washers are used, verify bolt tension in accordance with approved procedure for this project (see paragraph 3.8.D.1) and verify position of washers and method of tightening nut. If snap-off bolts are used, verify that all knurled ends have been snapped off. Periodically verify snap-off torques.
 2. Shop and Field Welding: Inspect and test during fabrication of structural steel assemblies and in accordance with AWS Codes, as follows:
 - a. Certify welders and conduct inspections and tests as required. Record types and locations of defects found in work. Record work required and performed to correct deficiencies.
 - b. Perform visual inspection of all welds.

- c. Perform random verification ultrasonic testing of shop full penetration welds.
 - d. Perform 100% ultrasonic testing, in accordance with ASTM E-164, on all field full penetration welds.
3. Camber: Inspect fabricator's procedures and material to ensure specified camber is achieved in accordance with referenced standards.

END OF SECTION