

DIVISION 05000 – METAL WORKS**05120 STRUCTURAL STEEL WORKS****05121 GENERAL****A- Description**

This section covers structural steel where indicated on the drawings and specified herein.

B- Applicable Code and Standards

The standards and codes applicable to only a portion of the work specified in this section are referenced in the relevant parts or clauses. Standards and codes, which are generally applicable to the work of this section, are listed hereinafter:

AISC -American Institute of Steel Construction

M 010 Manual of Steel Construction

8302 Code of Standard Practice for Steel Buildings and Bridges.

8314 Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts.

ASTM -American Society for Testing and Materials:

A 36 Structural Steel

A 307 Carbon Steel Externally and Internally Threaded Standard Fasteners

A 325 High Strength Bolts for Structural Steel Joints including Suitable Nuts and Plain Hardened Washers

A 490 Quenched and Tempered Alloy Steel Bolts for Structural Steel Joints

E109 Dry Powder Magnetic Particle Inspection AWS

AWS - American Welding Society:

B 3.0 Standard Qualification Procedure

D 1.1 Structural Welding Code

ANSI American National Standards Institute, Inc.

B 18.2.2.1 Plain Washers

SSPC Steel Structures Painting Council

SP 1 Solvent Cleaning

Signature of Client

Signature of Contractor

SP 2 Hand Tool Cleaning

SP 3 Power Tool Cleaning

C- Submittals

The following submittals are required:

- Detail Drawings and/or Shop Drawings
- Assembly, Erection and Installation Drawings and Manuals
- Quality Assurances/Quality Control Procedure
- Material, Equipment and Fixture Lists
- Test Reports

D- Transportation, Handling, Storage and Protection

1) Handling

Do not handle structural steel until paint has thoroughly dried Exercise care to avoid abrasions and other damage.

2) Protection

Stack material out of mud and dirt and provide for proper drainage Protect from damage or soiling by adjacent construction operations.

3) Storage

Storage of fabricated steel at the job site shall be the responsibility of the Contractor. Store material at the job site in a manner which does not exceed design loads of existing or newly-constructed structures. Protect material against corrosion or deterioration.

E- Quality Control

1) Inspection and Testing Structural Steel

Testing and structural steel will be performed by a testing laboratory.

2) Inspection and Testing -Bolt Connections

Bolted connections will be inspected by a testing laboratory in accordance with AISC 314 and as shown.

3) Inspection and Testing-Welding

Welding will be Inspected and tested by a testing laboratory during fabrication and erection of structural steel as follows:

Certify all welders and make inspections and tests as required. Record types and locations of all defects found in the work, the measures required and performed to correct such defects.

In addition to visual inspection of all welds, magnetic particle, ultra-sonic and radiographic inspection will be made of all welds as specified elsewhere in the Contract Documents. Magnetic particle inspection will be made on the root pass and finished weld.

The method of magnetic particle inspection will be in accordance with ASTM E 109. Any type of crack or zone of incomplete fusion or penetration will not be acceptable.

Radiographic inspection technique and standards of acceptance will be in accordance with AWS D 1.1.

Ultra-sonic Inspection will be performed in accordance with AWS D 1.1.

4) Welder Identifying Symbols

Each bolting crew and welder shall be assigned an identifying symbol or mark and all shop and field connections shall be so identified shop and crew or person making the connection.

5) Testing Laboratory

The testing laboratory shall be responsible for conducting and interpreting the tests. It shall state in each report whether or not the test specimens conform to all requirements of the Contract Document and shall specifically note any deviations therefrom.

6) Repair and Re-inspection of Welds

Repair defective welds in accordance with AWS D 1.1, Article 3.7; or replace the weld; and re-examine repaired and replaced welds by the method used to examine the original weld in addition, when defective welds are found, the testing laboratory shall determine the cause of the defective welding and institute immediate corrective action.

05122 PRODUCT

A- Material

a) Structural Steel

ASTM A 36 unless otherwise shown.

b) High-Strength Bolts

ASTM A 325 or ASTM A 490, heavy hexagon bolts with nuts and hardened washers.

- c) Unfinished Bolts
ASTM A 307 regular hexagon-bolts with nuts low carbon steel and washers conforming to ANSI B 18.2.2.1, type B.
- d) Filler Metal – Electrodes for Carbon Steel
Conform to AWS D 1.1. Structural Welding Code.
- e) Shop Primer Paint
SSPC – Paint 15 type I; compatible with finish coats of paint.
- f) Final Paint
Epoxy resin paint.

B- Shop Fabrication

Fabricate structural steel in accordance with referenced standards.

- a) Milling and Planing
Mill column and bearing stiffeners to give full bearing over the cross section. Plane contact surfaces of bearing plates. It is not necessary to plane bottom surfaces of plates on grout beds.
- b) Drilling and Punching
Drill or punch holes at right angles to the surface of the metal, not more than 2 mm larger than the connector diameter. Do not make or enlarge holes by burning. Drill material having a thickness in excess of the connector diameter and material thicker than 10 mm. Holes shall be clean-cut without torn or ragged edges. Remove outside burrs resulting from drilling operations.

C- Connections

- a) Requirements
Minimum connections shall comply with appropriate tables headed framed beam connections shown in the AISC Manual of Steel Construction. Seated connections may be used only when they do not interfere with architectural features.
- b) Non-Composite Beam Connections
For non-composite beams, the connections used shall be adequate to provide for the reaction due to the maximum uniformly distributed load that the beam is capable of carrying for its span, based on the allowable unit stresses, except where higher reactions are shown or specified elsewhere.

c) Composite Beam Connections

For composite beams, connections shall be adequate to provide for reactions as shown.

d) Bolts and Welds

All connections shall be one of the following:

- Unfinished bolts
- High-strength bolts
- Weld

D- Bolting

a) Requirements

Bolts shall be of a length that will extend not less than 6 mm (1/4 in.) beyond the nuts. Enter bolts into holes without damaging the thread.

b) High-Strength Bolts

Use high-strength bolts in bearing or friction as shown. Make high-strength bolted joints without the use of erection bolts. Bring members tightly together with sufficient high-strength fitting-up bolts, which shall be retightened as all the bolts are finally tightened. Protect bolt heads from damage during placing. Bolts that have been completely tightened shall be marked for identification.

c) High-Strength Bolt Connection Contact Surfaces

The contact surface in high-strength bolted connections shall be free of oil, paint, lacquer, or other coatings.

d) Tightening

Final tightening of high-strength bolts shall be by turn-of-nut method unless properly calibrated wrenches are specifically required. Each wrench shall be checked for accuracy at least once daily.

e) Unfinished Bolts

Use unfinished bolts in locations where high-strength bolts are not shown or specified to be used. Draw unfinished bolt heads and nuts tight against the work with a suitable wrench. Peen bolt threads for unfinished bolts to prevent the nuts from backing off.

E- Welding

a) Requirements

Do not begin structural welding until joint elements are bolted or tacked in intimate contact and adjusted to dimensions shown with allowance for any weld shrinkage that is expected. Weld heavy sections and those having a high

degree of restraint with low hydrogen type electrodes. No members are to be spliced without approval.

b) Qualifications of Welders

Welding shall be performed by operators who have been qualified as per AWS B 3.0 within the preceding one year period under AWS standard qualification procedure for the type of work required.

F. Surface Preparation

a) Cleaning

Clean all surfaces not otherwise specified in accordance with SSPC SP 2 or SSPC SP 3 as determined by the Engineer.

b) Shop Coat

Cleaning shall be done after fabrication and immediately prior to shop painting or shipment. Apply shop coat of paint within 4 hours after cleaning and before rust-bloom.

G- Painting

a) Requirements

All structural steel shall receive a shop coat of primer paint except as follows:

- Members encased in concrete.
- Contact surfaces of welded connections and areas within 50 mm of field welds.
- Contact surfaces of high-strength bolted connections.
- Milled surfaces.
- Top surface of steel beam flanges to receive shear connectors.

b) Primer Application

Apply specified primer by brush, spray, roller, or other approved means to provide a minimum dry film thickness of 0.05 mm, except for milled surfaces. No painting shall be done when the surface temperature of the steel is below the temperature at which condensation will occur. Apply paint thoroughly and evenly to dry surfaces in accordance with manufacturer's directions.

c) Application of 1st Final Coat

The first final coat shall be applied to the steel structure in the shop. A dry film thickness of 0.05 mm shall be provided. Any damages of the primer coat shall be repaired prior to the application of the 1st final coat. The manufacturer's instructions are to be considered.

d) Application of 2nd Final Coat

The second final coat shall be applied after erection of the structures. All damages of the primer and 1st final coat shall be repaired prior to application of 2nd final coat. The dry film thickness shall be 0.05 mm at least.

H- Galvanizing

Components should be galvanized after complete fabrication i.e. welding, drilling, etc. The process should consist of removal of rust and mill scale by pickling in hydrochloric acid or sulphuric acid followed by water wash and pre fluxing in tanks containing zinc ammonium chloride and then fluxing with ammonium chloride. The fluxed components should then be passed through a drying oven prior to immersion in a bath of virtually pure molten zinc.

Wherever specified by the Engineer zinc coating shall be applied in a manner and of a thickness and quality conforming to the requirements of ASTM A 123 Standards Specifications for zinc (hot galvanized) coating on products fabricated from rolled, pressed, and forged steel shapes, plates, bars and strips.

05123 EXECUTION**A- Erection**

a) Plumbing, Leveling, and Aligning

Individual pieces shall be plumbed, leveled, and aligned in accordance with the requirements of the AISC S 302.

- Drift Pins: Drift pins may be used only to bring together the several parts. They shall not be used in such manner as to distort or damage the metal.
- Temporary Bracing and Guy Lines: Temporary bracing and guy lines shall be provided to ensure proper alignment and to adequately protect all persons and property.

B- Field Painting

a) Touch-up Painting

Field touch-up painting shall comply with the requirements specified in Sub-section 05122 A "Materials" and G. "Painting".

b) Cleaning

After erection, clean exposed surfaces of field connections, unpainted areas adjacent to field connections, and damaged areas in the shop coat according to the same standards required for the shop coat, and paint the same primer used in the shop coat.

05124 MEASUREMENT & PAYMENT

- a) Unless otherwise specifically stated in the Bill of Quantities or herein, all items shall be deemed to be inclusive of, but not limited to the following:
 - i) Labour, material, goods and all cost in connection therewith e.g. conveyance, delivery, unloading, storing, returning, packing, handling, hoisting, lowering.
 - ii) All fixtures and all costs in connection therewith including costs of nuts, bolts, screws, and rivet heads and the like.
 - iii) Fabricating, welding, riveting, fitting and fixing material and goods in position including costs of holding-down bolts, anchor plates and the like.
 - iv) Use of plant.
 - v) Waste of materials.
 - vi) Establishment charges, overhead charges and profit.
 - vii) All other expenses, charges and taxes specified in Conditions of Contract.
- b) Works shall be measured net as fixed in position as per drawings and instructions of the Engineer. Each measurement shall be taken to the nearest 1/2" (12.5 mm) to establish weight. This rule shall not apply to any dimensions stated in the descriptions.
- c) Unit rates for structural steel work shall be given in terms of their weights in metric tons calculated from the net measurement, as per sub-clause (b) above, on the basis of 490 lb per cubic feet or other appropriate unit of standard weights. In arriving at these weights, tolerances for rolling margin and other permissible deviations from standard weights shall be ignored. No addition shall be made for nuts, bolts, screws, rivet heads, fillet welds and the like.
- d) The cost of all painting and/or galvanization of structural steel works, both at the factory at the Site, shall be deemed to be included in the unit rates for the structures in question.
- e) All steel, iron or other metal fittings, fixtures, embedded items, etc., required for the operational process and other purposes, shall be classified as structural steel works and shall either each be enumerated separately, stating the description briefly by reference to the relevant drawings, or grouped together and given in metric tons. Where only fixing in position of such items is required of the Contractor, it will be specifically mentioned in the Bill of Quantities.

*** End of Section 05120 ***

Signature of Client

Signature of Contractor

05130 STRUCTURAL WELDING**05131 GENERAL****A. Description**

This section covers general welding requirements and a program of non-destructive examination (NDE) of welded joints of structural components.

B- Applicable Codes and Standards

The codes and standards applicable to only a portion of the work specified in this section are referenced in the relevant parts and clauses. Codes and standards, which are generally applicable to the work of this section, are listed hereinafter:

<u>Sponsor</u>	<u>Number</u>	<u>Subject</u>
ASME	SFA 5.4	Corrosion-Resisting Chromium and Chromium Nickel Steel Covered Welding Electrodes.
ASME	SFA 5.9	Corrosion-Resisting and Chromium-Nickel Steel Bare and Composite Metal Cored and Standard Arc Welding Electrodes and Welding Rods.
ASNT	SNT TC 1 A	Personnel qualification and Certification
ASTM	A 435	Straight-Beam Ultrasonic Examination of Steel Plates for Pressure Vessels.
ASTM	A 577	Ultrasonic Angle-Beam Examination of Steel Plates.
ASTM	E 94	Recommended Practice for Radio-graphic Testing.
AWS	D 1.1	Structural Welding Code, Steel

C- Submittals**(01) Test Reports**

- Welders Qualification Records
- NDE Personnel Qualification Records.
- Welding Examination and Inspection Reports: Detailed records showing evidence of the quality of welding. For each section of weld inspected, furnish a report, which clearly identifies the work, the welder's identification, the areas of inspection the acceptability of the welds, and the inspector's signature. Each report shall be completed by the inspector at the time of inspection. Furnish a complete set of reports at the completion of work. For radiographic examination, furnish a complete set of radiographs in addition to the report.

The inspector shall be allowed to view any or all of the examination and shall have access to all reports and radiographs. Reports shall be submitted on approval report forms.

(02) Procedures

Welding and weld repair procedures.

05132 PRODUCTS**A- Materials**

Shielded metal arc welding shall be performed with low-hydrogen electrodes when welding carbon steels that are not listed in AWS D 1.1 and that have a specified allowable carbon content above 0.30 percent.

For austenitic (300 Series) stainless steels, welding filler metal shall conform to ASME SFA 5.4, type ER 308 L and SFA 5.9, type ER 308 L. Welding filler metal for welds between carbon and stainless steel shall conform to ASME SFA 5.4, type E 309. A stainless steel filler material shall have a minimum delta ferrite of five percent based on the certified chemical analysis and the WRC Diagram.

Maintain the receipt and disbursal of all welding filler materials and fluxes under strict control. Perform the storage, baking and drying in accordance with the manufacturers recommendations.

B- Welding requirements**(01) Welding Processes**

The processes listed in AWS D 1.1 are permitted, subject to the restrictions of article "C " Welding Process Restrictions.

(02) Alternative Welding Processes

Other welding processes will be considered, providing:

- a) Ability to use the process can be demonstrated satisfactorily. Information submitted shall complete details of material and joint preparation, welding equipment, welding techniques, welding procedures, record of qualification tests for each specific application, and appropriate additional tests required.
- b) The in-process welding control program and post weld heat treatment procedure are accepted. Information submitted shall include the extent of non-destructive examination and all inspection techniques employed throughout production.

(03) Joints Subject to Lamellar Tearing

Welded joints where a member is subject to stress in the through-thickness direction shall be welded by one of the following low hydrogen processes:

- submerged arc welding (SAW),
- gas metal arc welding (GMAW),
- flux cored arc welding (FCAW),

- shielded metal arc welding using EXXX5, EXXX6, or
- EXXX8 electrodes.

C- Welding Process Restrictions

The following restrictions shall apply:

a) Thickness

The maximum individual layer thickness for submerged arc welds shall not exceed 13 mm for material 32 mm thick or greater, and 10 mm for material less than 32 mm thick.

For plates 25 mm thick and over use low hydrogen electrodes listed in AWS D 1.1

b) Starting and Stopping Tabs

For submerged-arc welding, use removable starting and stopping tabs for longitudinal welds.

An alloying flux shall not be used.

c) Gas Metal Arc Welding (GMAW)

GMAW in the short-circuit transfer mode is restricted to the following:

- Materials not exceeding 6 mm (1/4 in) nominal thickness.
- Non-structural/, non-pressure retaining attachments, such as insulation clip and nameplates where the material being attached does not exceed 5 mm nominal thickness.
- Tack welds, temporary attachments, double welded joints or other applications where weld metal deposited by the GMAW short-circuiting process is subsequently removed.

d) Electro Slag Welding (ESW) and Electro Gas Welding (EGW)

Impact qualified procedures per AWS D 1.1., Appendix C, are required as a minimum.

e) Peening

Peening may be used on intermediate weld layers of thick welds. Peening of root and cover passes will not be acceptable. The use of pneumatic tools for slag removal is not considered peening and is acceptable.

f) Joints

Make welded joints by completing each weld layer before succeeding weld layers are deposited. Block welding shall not be used without prior written approval of the proposed methods and controls.

- g) Shop Paint

Remove shop paint from areas to be welded.

D- Preheat and Interpass Temperature (P & IPT)

- a) Preheat

Preheat shall be as required in AWS D 1.1.

- b) Carbon Steels

Carbon steel not listed in AWS D 1.1 shall have a preheat and interpass temperature of 150°C minimum when the thickness at the joint exceeds 25 mm.

- c) Measuring Temperature

Determine preheat and interpass temperature by temperature-indicating crayons, contact pyrometers or other approved means.

- d) Temperature Requirements

Preheat and interpass temperature requirements listed above shall also apply to tack welding, fillet, welds, attachment welds, and thermal gouging and cutting.

- e) Austenitic Stainless Steels

The maximum interpass temperature for welding austenitic stainless steel shall be 177°

E- Postweld Heat Treatment (PWHT)

Postweld heat treatment when required shall be in accordance with AWS D 1.1. Postweld heat treat carbon steels with base metal thickness of 38 mm or greater such as column-truss and girder connections. Heat the weldment within a temperature range of 595 - 650°C for one hour per 25mm (1 in.) of thickness.

F- Workmanship, Visual Quality Examination and Inspection

- a) General

In addition to the requirements of AWS D 1.1, paragraph 8.15, each weld shall be visually free of slag, inclusions and porosity.

- b) Butt Welds

Butt welds shall be full penetration welds, unless otherwise specified and permitted.

- c) Temporary Attachments

Avoid the use of temporary welded attachments during fabrication as much as possible. After fabrication is completed, remove flush with the base material without encroaching on the minimum required base material thickness. After the surface has been restored, examine all areas from which temporary

attachments have been removed by the same methods required for permanent fillet welds.

d) Additional Requirements

Do not begin structural welding until joint elements are bolted or tacked in intimate contact and adjusted to dimensions shown with allowance for any weld shrinkage that is expected. Weld heavy sections and those having a high degree of restraint with low hydrogen type electrodes. No member shall be spliced without approval.

G- Inspection and Testing

a) Personnel

Personnel performing NDE shall be qualified and certified in accordance with ASNT TC 1 A.

b) Examination Methods

Use the following examination methods as specified. The following list is in descending order. When a particular examination method is specified for a joint and the method is impracticable to use, use the next highest method practicable. The alternative method will be subject to approval. NDE procedures and techniques shall be in accordance with AWS D 1.1, section 6.7.

- Radiographic Method: In addition to the requirements of AWS D 1.1 comply with ASTM E 94.
- Ultrasonic method.
- Magnetic particle method.
- Liquid Penetrate Examination Method: Visible-dye, solvent-removable method only.

c) Members Designated for Examination

- 1) Welded Plate girders and Built-Up Members: Examine 100 percent of flange-to-flange and web-to-web welding by the radiographic method. For all web-to-flange and pipe column seam welding, examine ten percent of each welder's work as follows.

- Full penetration groove welds by the ultrasonic method,
- Fillet welds and partial penetration groove welds by the magnetic particle method.

2) Moment Connection Joints:

- Examine 100 percent of all flange-to-flange and web-to-web welding as follows:
- Full welds and partial penetration groove welds by the magnetic particle method.

- For all web-to-flange welding, examine ten percent of each welder's work as follows:
 - Full penetration groove welds by the ultrasonic method,
 - Fillet welds and partial penetration groove welds by the magnetic particle method.
- 3) Floor Beam and Girder Connections: Where floor beams or girders are to be connected to their supporting members using clip angles welded to the web, completely examine ten percent of the clip angles (at least one clip angle) welded by each welder, Use the magnetic particle method.
- 4) Column Base Plates: Examine 100 percent of all welding of columns to base plates, including associated stiffeners, as follows:
 - Full penetration groove welds by the ultrasonic method.
 - Fillet welds and partial penetration groove welds by the magnetic particle method.
- 5) Truss Connections: Examine 100 percent of all welding of truss member connections as follows:
 - Full penetration groove welds by the ultrasonic method.
 - Fillet welds and partial penetration groove welds by the magnetic particle method.
- 6) Diagonal Bracing Connections: Examine 100 percent of all welding for connection of diagonal bracing as follows:
 - Groove welds by the ultrasonic method.
 - Fillet welds by the magnetic particle method.
- 7) Circular Pipe or wide flange Columns: Examine 100 percent of all welding for circular pipe columns by the ultrasonic method.
- 8) Joints Subject to Lemellar Tearing:
 - Welded joints where a member is subject to stress in the through-thickness direction shall be examined by ultrasonic testing for lamellar tears, unless the member subject to stress in the through-thickness direction has been fabricated from lamellar tear resistant steel as defined in Section 05120 - Structural Steel. Such joints shall be subject to all other specified examination, whether fabricated from lamellar tear resistant steel or not.
 - For plates 25 mm (1 in.) or more in thickness, ultrasonic testing for lamellar tears shall be made in an area 13 mm below the weld and up to 25 mm in thickness. Such testing shall be made in an area below the weld at the centre of the plate and outward from the edge of the weld up to a distance equal to the thickness of the plate.

- If possible, ultrasonic testing for lamellar tears shall be made with a straight beam from the plate surface opposite the weld in accordance with ASTM A 435. Otherwise, such testing shall be made by the angle-beam method in accordance with ASTM A 577.
- Indications which produce a response greater than 20 percent of the reference level shall be investigated to determine the identity, location, and shape of the source of the indication.
- Discontinuities interpreted as cracks or laminations (lamellar tears) within the test area shall be cause for rejection of the weld.
- Members with lamellar tears shall be repaired or replaced at Contractor's expense.

d) Requirement for Ten Percent Examination

- 1) Examine a 300 mm section of weld in each 3 m increment of each welder's work. If the examination meets the acceptance standards of AWS D 1.1, the 3 m of weld represented will be accepted.
- 2) If the examination fails to meet the acceptance standards, examine two additional 300mm sections in the 3 m increment. If both of these examinations meet the acceptance standards, the 3 m of weld represented will be accepted.

Repair the defects detected in the first examination and re-examine.

- 3) If one or both of the examinations fails to meet the acceptance standards, examine the remaining weld of the 3 m increment. Repair the areas that do not meet the acceptance standards and re-examine.

e) Repair or Replacement of Defective Welds

- 1) Welds found to contain defects which are prohibited by AWS D 1.1 shall be repaired by methods permitted by AWS D 1.1 or shall be replaced. Re-examine repaired and replaced welds by the same method and acceptance standard used to examine the original defective weld.
- 2) In addition to the above, when welds are found to contain prohibited defects, determine the cause of the defective welding and take immediate corrective action. Require shop inspectors to check and verify that corrective actions are instituted.

*** End of Section 05130 ***

05510 MISCELLANEOUS METAL WORKS**05511 GENERAL****A- Description**

This section covers miscellaneous metalwork where indicated on the drawings and specified herein.

This section includes furnishing, fabricating, delivering, and installing miscellaneous steel and iron components, including anchors, fastenings and other supplementary parts necessary to complete the miscellaneous metal work including ladders, railings, roll up shutters, gratings, protection screens over roof openings.

B- Applicable Codes and Standards

The standards and codes applicable to only a portion of the work specified in this section are referenced in the relevant parts or clauses. Standards and codes which are generally applicable to the work of this section are listed hereinafter. Standards and codes which are generally applicable to the work of this section are listed hereinafter.

ASTM -American Society for Testing and Materials:

ASTM	A 27	Mild - to Medium-Strength Carbon-steel Castings for General Application.
ASTM	A 36	Structural Steel
ASTM	A 47	Malleable Iron Castings
ASTM	A 48	Grey iron castings
ASTM	A 53	Pipe, Steel, Black and Hot Dipped, Zinc-Coated Welded and Seamless.
ASTM	A 108	Cold-Finished Carbon Steel bars and Shifting
ASTM	A 120	Black and Hot-Dipped Zinc-Coated Welded and seamless Steel Pipe for ordinary Use.
ASTM	A 123	Zinc (Hot-Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates, Bars and Strip.
ASTM	A 153	Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
ASTM	A 159	Automatic Grey iron Castings.
ASTM	A 283	Low and Intermediate Tensile Carbon Steel Plates of Structural Quality.
ASTM	A 307	Carbon Steel Externally Threaded Standard Fasteners.
ASTM	A 325	High-Strength Bolts for Structural Steel Joints

ASTM	A 366	Steel Sheets, Carbon, Cold-Rolled, Commercial Quality.
ASTM	A 385	Providing High Quality Zinc Coatings (Hot-Dip) on Assembled Products.
ASTM	A 386	Zinc Coating (Hot-Dip) on Assembled Steel Products.
ASTM	A 501	Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
ASTM	A 525	General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process.
ASTM	A 526	Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process. Commercial Quality.
ASTM	A 536	Ductile Iron Castings.
ASTM	A 570	Hot-Rolled Carbon Steel Sheet and Strip, Structural Quality.
ASTM	A 663	Merchant Quality Hot-Rolled Carbon Steel Bars, Subject to Mechanical property Requirements.
ASTM	A 675	Steel Bars and Bar-Size Shapes, Carbon, Hot-Rolled Special Quality, Subject to Mechanical Property Requirements.

Federal Specification (General Service Admin):

FF-92A(1)	Washers. Metal, Flat (Plain)
FF-S-325	Shield, Expansion: Nail, Expansion; and Nail Drive Screw (Devices. Anchoring, Masonry)

AWS -American Welding Society:

D1.1	Structural welding Code
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NAAMM -National Association of Architectural Metal Manufacturers:

Metal Bar Grating Manual

Pipe Railing Manual

SSPC -Steel Structures Painting Council:

PT	3-64	Basic Zinc Chromate-Vinyl Butyral Wash coat
SP	1	Solvent Cleaning
SP	3	Power Tool Cleaning
SP	7	Brush-Off Blast Cleaning

Part -2	Red Lead, iron Oxide, Raw Linseed Oil and Alkyd Primer
Part -3	Red Lead, Iron Oxide, and Fractionated Linseed Oil Primer
Part -12	Cold Applied Asphalt Mastic (Extra Thick Film)

AASHTO -American Association of State Highway and Transportation Officials:

Standard Specifications for highway bridges.

AISC -American institute of Steel Construction:

S	326	Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
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ANSI -American National Standards institute:

B	18.22.1	Plain Washers
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FS-Federal Specification (U.S. Govt. G.S.A. Spec.):

FF-SO325, Shield Interim Amendment 3	Expansion; Nail, Expansion; and Nail, Drive Screw Expansion; Nail Drive Screw (Drives, Anchoring Masonry)
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C- Submittals

The following submittals are required:

- a) Detail, Drawings and/or Shop Drawings and Outline Drawings showing erection mark numbers.
- b) Certificate of Compliance
- c) Design Analysis and Calculations as required
- d) Samples Railings including connections and attachments, not less than 150 mm (6 in.) long.
- e) Manufacturer's Data

Submit manufacturer's data sheets for each type of component.

D. Galvanizing

Iron or steel products to be zinc coated shall be hot-dipped after fabrication in according with ASTM A 123, A 375 as applicable. The zinc coating shall weight at least 0.61 kg/m² Fabrication shall include operations such as shearing, punching, bending, forming and welding. Unit shall be fabricated complete, or in the largest practical sections, before galvanizing. Surfaces on which the zinc coating is damaged shall be required by a thorough wire.

05512 PRODUCTS**A. Materials****a) General Requirements**

For fabrication of miscellaneous metal work which will be proposed to view in the finished work, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names, and roughness.

b) Structural Steel

ASTM A 36

c) Steel Plates for Bending for Cold Forming

ASTM A 283 m Grade C Thickness shown for raised pattern safety plates is exclusive of projected pattern.

d) Steel Pipe

ASTM A 120 Schedule 40

e) Steel Tubing

ASTM A 501 hot-formed, furnace butt welded or seamless process.

f) Steel bars and Bar Size Shapes.

ASTM A 108, ASTM A 663, ASTM A 675, Grade 65, or ASTM A 36.

g) Cold Finished Steel Bars

ASTM A 108, grade as selected by fabricator

h) Cold Rolled Carbon Steel Sheet

ASTM A 366 and ASTM A 570

i) ASTM A 526 galvanized in accordance with ASTM A 525, Designation 90.**j) Grey iron Castings**

ASTM A 48, Class 30

k) Malleable Iron Castings

ASTM A 47, grade as selected by fabricator

l) ASTM A 48, Class 30 or ASTM A 159 Grade 63000

- m) Steel Pipe
ASTM A 53, Type S, Grade A, suitable for close coiling, black finish unless galvanizing is required; standard weight (Schedule 40), unless otherwise indicated or required performance criteria
- n) Fasteners- Malleable Iron Castings
ASTM A 47
- o) bolts and Nuts
ASTM A 307 Grade A bolts
1. Unfinished Bolts ASTM A 307, Grade A, regular hexagon bolts with nuts of low carbon steel and washers conforming to ANSI B18221 Type B.
 2. Anchor Bolts
 - Headed Bolts and Nuts ASTM A 307, Grade A
 - Threaded Rods and Anchor Plates ASTM A 36
 - Washers ASTM A 325
 3. Sleeves for Anchor Bolts. Galvanized be steel not less than 0.4 mm (1/4 in.) thick or high polyethylene unless otherwise approved
- p) Rivets
ASTM A 325 ASTM A 325
- q) Machine Screws
Carbon steel, cross-recessed, Flathead minimum tensile strength 414 MPa (60,000 psi).
- r) Expansion Anchors
Externally threaded wedge anchors conforming to the requirements of FA FF-S 325, Int. and 3, Group II, Type 4 Class I.
1. Bolts: Zinc plated, chromate dip, SAE Grade 5 or better
 2. Anchors: Wedge type with one-piece wrap around stainless steel clip
 3. Pull Out and Shear Values: Meet requirements of manufacturer's published equal
 4. Products Molly "Para-bolt", Phillips, "Wedge Anchors", Hilti "Quikbolt", or approved equal

- s) Concrete inserts
Threaded or wedge type, galvanized ferrous castings, either malleable iron ASTM A 47 or cast steel ASTM A 27. Provide bolts, washers, and shims as required hot-dip galvanized ASTM A 153.
- t) Wedge- Type Concrete Inserts
Wedge-type concrete insert shall be hot-dip galvanized box-type ferrous castings designed to accept 6 mm to 20 mm dia-meter bolts with special wedge-shaped heads. The carbon steel bolts with wedge-shaped heads, and the nuts, washers and shims shall be galvanized.
- u) Threaded- Type Concrete Inserts
Threaded-type concrete inserts shall be hot-dip galvanized ferrous castings threaded internally to receive 20 mm diameter machine bolts or threaded rods.
- v) High Strength Bolts
ASTM A 325.
- w) Plain Washers
Plain washers shall be round, general assembly grade, carbon steel and shall comply with FS FF-W-92A (1).
- x) Masonry Anchors
Masonry anchors shall comply with FS FF-S-325.
- y) Fasteners and Anchorage Devices
Type, Grade, Class, and style best suited for the respective purpose; galvanized for exterior use.
- z) Steel Chain
Galvanized welded type proof coil steel, 5 mm (3/16 in.) nominal size, minimum 33 links/m (10 links/ft) proof loading not less than 450 kg (1000lb). Provide complete with eye bolts and snap fasteners at each end.
- aa) Galvanizing
 - 1. ASTM A 153 for galvanizing Iron and steel hardware
 - 2. ASTM A 123 for galvanizing rolled, pressed, and forged steel shapes, plates, bars, and strip 3 mm (1/8 in.) thick and heavier.
 - 3. ASTM A 386 for galvanizing assembled steel products.
- bb) Paint
 - 1. Ferrous Metal Primer: SSPC Paint 3. compatible with finish coats of paint
 - 2. Galvanizing Repair Paint: Zinc-rich paint for repairing galvanized surfaces and field welds in galvanized steel.

3. For separating Dissimilar Metals: SSPC Paint 12
 4. Primer for Galvanized Ferrous Metal: Vinyl butyral washcoat conforming to the requirements of SSPC PT e.
 5. Asphalt on Cast Iron: Asphalt-base emulsion conforming to ASTM D 1187 paint conforming to SSPC-Paint 12 or other similar suitable material that is adherent, not brittle and without tendency to scale.
- cc) Ductile Iron
- ASTM A 536, Grade 60-40-18 or 65-45-12
- dd) Neoprene Gaskets
- Approved commercial product
- ee) Weld Metal
1. Typical: E 7028 low hydrogen or approved equal
 2. Galvanized Steel: For galvanized steel use E 7010/g or approved equal.

B- Workmanship

Metalwork shall be clean and free from loose mill-scale flake rust and rust pitting, and shall be well-formed and finished to shape and size, with sharp lines and angles, Metalwork bent by shearing or punching shall be straightened. Wide members shall be drilled or punched for the smaller members to pass through, and the small members shall be secured by spot welding. Similar members, where passing, shall be halved together, and abutting members shall be welded. All exposed fastenings shall be of the same material, colour and finish as the metal to which applied unless other wise shown.

Metal work shall be properly countersunk to receive the required hardware and shall be provided with the proper bevels and clearances. Plates for mounting hardware shall be welded in place.

C- Shop Fabrication

Detailing, fabricating and erecting miscellaneous metal shall conform to the requirements of AISC S 326

a) Supplemental Parts

Include supplementary parts necessary to complete miscellaneous metalwork through not definitely shown or specified herein.

b) Measurement and Dimensions

Verify measurements and dimensions at the job site and cooperate in the coordination and scheduling of the work of this section with the work of related trades (with particular attention given to the installation of items embedded in concrete and masonry) so as not to delay job progress.

c) Forming of Exposed Work

Form exposed work true-to-line, and level, with accurate angles and surfaces and straight, sharp edges. Ease exposed edges to a radius of approximately 1 mm (1/32 in.) unless otherwise shown. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

d) Forming of Exposed Connections

Form exposed connections with hairline joints flush, and smooth; using concealed fasteners where possible. Exposed threaded portion of bolts and screws shall be cut off flush with adjacent metal. Cut drill, punch, and tpa as required for the installation and attachment of other work to miscellaneous metal work.

e) Forming Built-in Metal Work

Metal work built in with concrete or masonry shall be formed for anchorage, or be provided with suitable anchors, or other anchoring device shown or required to provide support for intended use. Furnish such metal work in ample time for setting and securing in place.

f) Welds

Make joints as strong and rigid as adjoining section. Make welds continuous along entire line of contact except where spot welding is indicated. Grind exposed welds flush and smooth to match and blend with adjoining surfaces. Where bolted or riveted connections are indicated, such connections may be welded.

g) Non-removable connections in weldable materials shall be welded unless otherwise shown. Welds shall be finished flush and ground smooth on surfaces which are exposed after installation. Welding shall be in accordance with AWS D1.1. Welded joints shall be completely sealed with not less than a 5 mm fillet weld.

h) Threaded Connections

Make thread connections up tight so that threads are entirely concealed. Abutting bars shall be shouldered and headed, doweled, and pinned. Rivet, bolt, and screw heads shall be flat and countersunk in exposed work and else where as required. Carefully machine, fit, and secure removable members by means of Allen set screws of proper size and spacing.

i) Galvanizing

All ferrous metal work at exterior and items embedded in concrete shall be galvanized after fabrication.

D- Shop Painting

1) General

Shop paint miscellaneous metal work, except members or portions of members to be embedded in concrete or masonry, surfaces, and edge to be field welded, and galvanized surfaces, unless otherwise specified.

2. Cleaning and Preparation
 - a) Clean and prepare metal surfaces before applying shop coat, Remove rust and mill scale in accordance with SSPC SP-3 except conform to SSPC SP-7 where required for special paint or coating. Achieve anchor profile between 0.025 mm (1 mil) to 0.075 mm (3 mils).
 - b) Remove oil, grease, and similar contaminants in accordance with SSPC SP-1.
3. Priming

Immediately after surface preparation, apply primer in accordance with manufacturer's instructions. Use painting methods which will result in full coverage and give a dry film thickness and 0.025 mm (2.0 mil) to 0.10 mm (4.0 mils).
4. Painting

Apply one shop coat to fabricated metal items, except apply two coats of paint to surfaces inaccessible after assembly or erection. Change colour of second coat to distinguish it from the first.
5. Coating

Coat cast iron frames and covers with asphalt evenly and smoothly on all surfaces.

E- Fabrication – Specific items

(01) Steel Ladder

- a) Provide steel ladders designed and constructed to support a live load of 115 kg (250 lbs) per rung or as specified, complete with stringer supporting brackets and rungs of the size and dimensions shown.
- b) Provide non-slip surface on the top of each rung, either by coating the rung with aluminium oxide granules set in epoxy resin adhesives, or by using a type of manufactured rung which is filled with aluminium oxide grout.
- c) Ladders, unless shown otherwise, shall be fabricated with 70 mm by 10 mm steel side rails and 20 mm diameter steel bar rungs at 200 mm centres. The ladders shall be securely bolted to the floor, at the top and intermediately on the wall at spacing of not over 2 m centres. Safety cages built-up of welded galvanized steel shapes shall be provided on the ladders where shown.

(02) Open Riser Stairs

- a) Provide open rise steel stairs designed and constructed to support a live load of 5 kpa (100 psf) or as specified.
- b) Provide stringers, supporting brackets, toe guards, carrying angles, treads, platforms, and railings of the size and dimensions shown. Comply with requirements specified hereinafter for railings.

- c) Tread shall be "Type IR4" (Reliance Steel Products Co.) or approved equal, with "Relgrint" abrasive nosing and plain bars, except checker plate nosing where shown.

(03) Sixty-Degree ladders

- a) Provide sixty-degree ladders designed and constructed to support a live load of 5 kpa (100 psf) or as specified.
- b) Provide stringers, supporting brackets, toe, guards, carrying angles, treads, platforms and railing of the size and dimensions shown. Comply with requirements specified hereinafter for railing.
- c) Treads shall be same as specified for open riser stairs.

(04) Ladder Rungs

Provide individual ladder rungs designed and constructed to support a live load of 114 kg (250 lbs) per rung. Rungs shall be of steel with abrasive surface consisting of aluminium oxide granules set in epoxy resin adhesive.

(05) Railings

- a) Provide steel railings of design and dimensions shown, with smooth bends and welded joints ground smooth and flush, designed and constructed to withstand a 91 kg (200 lb) load, or as specified, applied at any point, downward or horizontally, complete with all sleeves, brackets, bolts, and fastening devices as required for a complete installation.
- b) Provide gratings of steel or aluminium, as shown; exterior steel grating galvanized.
- c) Provide hinged and removable grating sections where shown, with end-banding bars for each panel and each openings, saddle clip anchors designed to fit over bearing bars, and stud bolts with washers and nuts, unless otherwise shown.

(06) Loose Lintels

- a) Provide loose steel lintels shown and as required over openings in masonry walls, partitions and shafts for installation under Division 4000 "Masonry Work".

Include lintels for mechanical openings as required. Provide lintels 0.3 m (12 in.) longer than the width of the openings at which they are installed.

- b) Where metal door frames are provided with the specified integral head reinforcement, provide loose lintels only for such openings 1 m (3 ft.) wide and wider.

(07) Miscellaneous Framing and Supports

- a) Provide steel framing and sub-framing shown on drawings and not specifically mentioned to be provided as part of the work of other trades.

- Fabricate miscellaneous units to sizes, shapes, and profiles shown or, if not shown, of required dimensions to receive adjacent other work to be retained by framing. Fabricate from structural steel shapes and plates and steel bars, of welded construction using mitred joints for field connection, except where otherwise shown. Cut, drill, and tap units, to receive hardware and similar items.
- Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed. Space anchors 0.6 m (24 in.) p.c. and provide minimum anchor units of 32 mm x 200 mm (1 1/4 in. x 8 in.) steel straps, except as otherwise shown.

(08) Structural Steel Door Frames

Fabricate shapes shown; fully weld joints unless otherwise shown. Provide hooked steel anchors, length as required for a minimum embedment in concrete of 150 mm (6 in.) unless otherwise shown. Weld anchors to frame jambs not more than 300 mm (12 in.) from bottom and head of frames and space anchors not more than 760 mm (30 in.) apart at heads and jambs. Extend frames to floor.

(09) Hatch Doors

Fabricate doors and frames as shown, joints at frame corners fully welded, doors leveled to a true plane, perimeter stiffener angles set to properly clear frames and welded to face plate with 20 mm {3/4 in.} long welds spaced not more than 150 mm (6 in.) along contact edges. Provide extra-heavy full surface welding-type hinges mounting plates as required. Provide latching dogs with suitable wedge-type keepers to seal doors tight all around and arranged so that door can be dogged and undogged from both inside and outside.

Secure rubber strip gaskets with adhesive recommended by the gasket material manufacturer. Run gaskets continuously along all edges of doors, with either mitered corner joins or integral corners. Keep gaskets free of paint.

(10) Angle Window Frames

Construct steel angle frames for lock-strip glazing gasket as shown, sides parallel and square, joints welded all around and ground smooth and surfaces in contact with glazing gaskets.

(11) Metal Stair Nosing

Cast aluminium with silicon carbide or aluminium oxide abrasive grits, sizes 1.59 mm to 1.07 mm {granule numbers 16 to 24}, uniformly spread and cast into walking surface, embedded not less than 0.8 mm {1/32 in.} at the rate of not less than 610 g/m² (2 oz/ft²) with plain unfluted walking surface and with wind-type anchors for screw application. Provide where shown at concrete stairs.

(12) Corner Guards

- a) Corner guards shall be single piece type of minimum 6 mm (1/4 in.) steel for each location securely anchored in place.
- b) Provide corner plates on chamfered external corners. Fabricate from 6 mm (1/4 in.) minimum thick steel plate as detailed.

- c) Column corner covers in vehicle areas shall be 75 mm x 75 mm x 6 mm (3 in. x 1/4 in) angle.
- d) All external corners in areas subject to vehicle or cart traffic require protection.

(13) Checkered Plate

Trench covers and covers for pits shall be raised pattern steel plate conforming to ASTM A 36, set in angle frames which are anchored to the concrete, thickness as shown. Continuous trench covers shall be cut in convenient lengths for handling and each shall be provided with finger holes. Provide standards two-way raised pattern. Thickness shown in nominal and does not include the height of raised pattern. Provide structural steel supports associated with checkered plate.

(14) Steel Frames

Steel frames for duct openings scuttles, mechanical equipment, louvres and other frames indicated as structural shapes, shall be neatly fabricated to the exact size required. Corners shall neatly joined, welded and ground smooth. Concealed anchors for securing to concrete or masonry shall be welded on the back at the spacing shown.

(15) Pipe Sleeves

Pipe sleeves through masonry or concrete walls, floors, and footings for piping, conduits, sub-drains, wall hydrants and similar items shall be standard-weight iron, mild steel or cast iron, sized to allow 8 mm between the sleeve and the pipe.

(16) Stairways

Metal stairways, platforms, and handrails shall be shop-assembled in the largest units suitable handling and shipping.

(17) Anchor Bolts

Anchor bolts shall be as detailed or as approved. Anchor bolts shall be carefully located and built into the connecting work. When anchor bolts are installed in pipe sleeves, the pipes shall be completely filled with grout at the time the grout pads are constructed or at the time the column bases or bearing assemblies are placed. Swede bolts installed in holes shall be set in epoxy- grout or other suitable material as approved.

(18) Traffic Barriers

Traffic barrier to be type Doorman Loon or equal an approved to the sizes here shown.

05513 EXECUTION

A- Installation

1. Bolts and Plugs

Except where otherwise specified for a particular item of work or for built-in work, fasten metal work to solid masonry with expansion bolts and to hollow block with toggle bolts. Fastening to wood plugs in masonry will not be permitted. Drill

holes for plugs or bolts to the exact diameter of the plug bolts, using a rotary drill for concrete and a percussion drill for other masonry. Provide screws threaded full length to the head of the screw.

2. Fastening

Install work as shown, plumb, level, and in-line with adjacent materials where required. Provide fastenings as indicated on the drawings, specified herein, or as shown on shop drawings.

3. Surface Protection

Protect finished surfaces against damage during subsequent construction operations and remove such protection at time of substantial completion.

4. Delivery

Deliver items, which are to be built into the work of other sections in time so as not to delay the progress of the work.

5. Vertical Ladders

Secure vertical ladders to masonry or concrete with a minimum of two 16 mm {5/8 in.} diameter expansion bolts at each bracket, unless additional attachments are required to sustain imposed loads.

6. Welding

Weld gratings to supporting steel, except for sections, which are hinged or required to be removable.

7. Touch-Up

Touch-up marred and abraded surfaces with the specified paint after erection in the field.

8. Anchor Bolts

Set anchor bolts accurately and hold in place by template. Centre sleeves on anchor bolts.

a) Use sleeves on bolts for mechanical equipment.

b) Use two nuts for anchor bolts securing vibrating equipment. After concrete is placed, the portion on anchor bolts shall be cleaned, coated with heavy grease, and wrapped with Kraft paper.

05514 MEASUREMENT & PAYMENT

a) Unless otherwise specifically stated in the Bill of Quantities or herein, all items shall be deemed to be inclusive of, but not limited to the following:

- i) Labor, materials, goods and all costs in connection therewith e.g. conveyance, delivery, unloading, storing, returning, packing, handling, hoisting, lowering.
- ii) All fixtures and all costs in connection therewith including costs of nuts, bolts, screws, rivet heads and the like.
- iii) Fabricating, welding, riveting, fitting and fixing materials and goods in position including costs of holding-down bolts, anchor plates and the like.
- iv) Use of plant.
- v) Waste of materials.
- vi) Establishment charges overhead charges and profit.
- vii) All other expenses, charges and taxes specified in Conditions of Contract.
- b) Works shall be measured net as fixed in position as per drawings and instructions of the Engineer. Each measurement shall be taken to the nearest 1/2" (12.5 mm) to establish weight. This rule shall not apply to any dimensions stated in the descriptions.
- c) Unit rates for all metal work shall be given in terms of their weights in metric tons calculated from the net measurement, as per sub-clause (b) above on the basis of appropriate standard weights. In arriving at these weights, tolerances for rolling margin and other permissible deviations from standard weights shall be ignored. No addition shall be made for nuts, bolts; screws rivet heads, fillet welds and the like.
- d) The cost of all painting and/or galvanization of miscellaneous metal works, both at the factory and at the Site, shall be deemed to be included in the unit rates for the metal work in question.
- e) All steel, iron or other metal fittings, fixtures, embedded items, etc., required for the operational process and other purposes, shall be classified as miscellaneous metal works and shall either each be enumerated separately, stating the description briefly by reference to the relevant drawings, or grouped together and given in metric tons. Where only fixing in position of such items is required of the Contractor, it will be specifically mentioned in the Bill of Quantities.

*** End of Division 05000 ***