

## **SECTION 6300 STRUCTURAL STEEL WORKS**

### **6301 General**

#### **(1) General**

This Section covers all structural steel works for the building.

#### **(2) Scope of Works**

The Contractor's scope of work shall include design, manufacture, and delivery to Site and installation required for the Structural Steel Works. The works include, but are not limited to the following:

- a. Roof truss, beams, girders and crane girders
- b. Designing and performing of all connections for the structural steel include welding electrodes, high strength bolting, etc.
- c. Anchor bolts, sole/base plates, concrete expansion anchors and embedded parts as required.
- d. Unloading, storing, protecting, removing from storage and erecting of all parts.
- e. Surface protection including cleaning, painting, etc.

### **6302 Applicable Codes and Standards**

The codes and standards of the following organizations are specifically applicable to the design, manufacture and testing of the work covered by this Specification:

AISC	American Institute of Steel Construction
AISE	Association of Iron and Steel Engineers
ANSI	American National Standards Institute
AREA	American Railway Employing Association
ASTM	American Society for Testing and Material
AWS	American Welding Society
SSPC	Steel Structures Painting Council, USA
SIS-05.59.00	Pictorial Surface Preparation Standards for Painting Steel Surfaces
UBC	Uniform Building Code of USA
BS 5950	Design, Material and Workmanship
ISO 7411	High Strength Friction Bolts
BS 5135	Welding
BS 639	Electrodes
BS 5493	Cleaning and Protective Coating
ISO 1459	Galvanizing
BS 3900	Inspection of Welding

Specifically the following documents or the equivalent shall apply for the works of this Specification:

AISE Manual of Steel Construction

## **6303 Submittals**

### **(1) Shop Drawings**

Shop drawings showing shall be prepared with complete details of fabrication of all structural steels, supports, frames and accessories including plan views, elevations, sections, details and fastening methods for this complete scope of works. The shop drawings shall be prepared in conformity with the best modern practice and with due regard to economy in fabrication and erection. Shop drawings shall be submitted prior to the fabrication.

### **(2) Test Reports and Certificates**

The Contractor shall make copies of material certificates, mill test reports and other test reports required by applicable codes or standards available. Those reports shall be submitted on request to the Engineer after completion of the tests.

### **(3) Qualification Reports**

Copies of welding qualification reports, quality control reports, and other reports as specified or required shall be furnished by Contractor to the Engineer, during execution or upon completion of the work.

### **(4) As-Built Drawings**

As-built drawings shall be submitted to the Engineer upon completion of the works.

## **6304 Materials**

### **(1) Steel Materials**

All materials shall conform to the requirements of the following Table 6000-3 and 6000-4 or approved equal.

**Table 6000-3 Material for Structural Steel works**

ITEM NO.	MATERIAL	ASTM STANDARDS AND CODES UNLESS NOTED
1.	Rolled beams, bars, channels, plates and angles, bracing, structural tees	A36
2.	Plate girders	A36
		A572 Grade 50
		A588 Grade 50
		A588 Grade 46
		A588 Grade 42
3.	Columns	A36 or A572 or A588
4.	Cover plates	A36 or A572 Grade 50 A588 Grade 50
5.	Column base plates and splice plates	A36
6.	Connection bolts	A325F
7.	Welding	AWS D 1.1
8.	Column Anchor Bolt	A36 or A307 or A193 Grade B7

**Table 6000-4 Additional Requirements for Structural steel**

Material Item	Standard	Additional Requirements
1. Structural	ASTM A 36	Use for all structural steel other steels are specifically indicated in the Specification and except for round tubular bracing and other steels specified in this table.
2. High-Strength Steel	a. ASTM A572 b. ASTM A588	Grade, as required. Use yield as required.
3. High-Strength Bolts	AISC Specification for Structural Joints Using ASTM A325	a. <u>Bolts and Nuts</u> : Use the following materials unless otherwise indicated:  a1. For bolt sizes through 22 mm diameter, use A325, Type 1 steel.  a2. For other size bolts, use steel as indicated in the Bid document.  b. <u>Washers</u> : <u>A325 Bolts</u> : One washer under the head or nut, whichever is the element turned in tightening.

## **6305 Design**

### **(1) General Provisions**

The Contractor prior to fabrication shall submit the shop drawings including typical calculations for each connection type for review. Such review shall in no way be interpreted as constituting approval of the adequacy of such design for their intended use and shall not relieve Contractor of complete design responsibility and from fulfilling all obligations under the Contract.

### **(2) Design Requirements**

The design of structural steel shall conform to all applicable requirements of the AISC Manual of Steel Construction and also conform to the requirements of the following specifications:

- a. The new section shall have close, but not smaller, statically characteristics to the one, which is being, replaced (section modulus, moment of inertia, etc.)
- b. The Contractor shall prove to the Engineer that the structural design is no affected by the change.
- c. The Contractor shall submit the relevant structural analysis and the drawings modified accordingly to the Engineer.
- d. The change of section does not induce any additional costs to the Engineer.
- e. The change shall be reviewed and shall be approved by the Engineer.
- f. Connection details shall be designed by the Contractor to cover the most unfavorable load cases used for the design of the members.
- g. Generally connections shall be designed to cover the full section properties of the connected members, if not otherwise directed or approved by the Engineer.

## **6306 Fabrication**

### **(1) General Provisions**

#### **(a) Conformance**

Fabrication of Structural Steel shall conform to all applicable requirements of codes and standards and other Standard Specifications specified in this Section, and to all requirements of this Sub-Section (1) (b).

#### **(b) Fabrication Requirements for Plumbing up and Leveling**

- a. The structures shall be plumbed and leveled such that deviations in the completed work do not exceed the requirements of the AISC Code of Standard Practice or approved equal.
- b. These requirements shall be fully considered in fabrication, and Contractor's shop drawings shall be clearly marked with these restrictions.

(c) Misfits

- a. Attention is specifically directed to the requirement of the AISC or approved equivalent Code of Standard Practice and Quality Criteria and Inspection Standards, with respect to correction of fabrication errors. Any errors in shop work which prevent proper field assembly and fit up will be reported, as soon as they are discovered, to the Engineer and to the fabricator by the Contractor. The Contractor shall then make immediate substitute or arrange for correction at no cost to the Engineer.
- b. The allowable limits for reaming the connection bolt holes for fit up in the shop or in the field shall conform to the requirements of the AISC or approved equivalent Quality Criteria and Inspection Standards. If fit up of bolts during erection in the field cannot be obtained by reaming the fabricated boltholes within these limits, it is considered that there are errors in fabrication, and these errors shall be rectified in accordance with statement above.

**(2) Connections**

All connections shall be welded or high-strength bolted, in the shop or field as follows:

(a) Shop Connections

All members and details shall be fabricated by welding or high-strength bolting, using FRICTION-TYPE connections; and welding may be used in combination with the high-strength bolting completed prior to welding. The Contractor shall submit with his Bid, a schedule of where he proposes to use each method of fabrication, and, in general, the members, connections, etc. included under each method.

(b) Field Connections

All connections shall be made with high-strength bolts, using FRICTION-TYPE connections conforming to the codes and standards, unless otherwise indicated.

(c) Welding

All welding shall be clearly indicated on the shop drawings. The Contractor shall provide all end and edge preparations for field welding.

(d) High Strength Bolting

(i) Conformance:

High-strength bolting shall conform to the applicable requirements of the AISC Specification for Structural Joints Using ASTM A325 Bolts or approved equal codes and standards for friction-type connections, unless otherwise indicated.

(ii) Bolt Types:

Shall be as indicated in Table 6000-4.

(iii) Bolt Holes:

Shall be 1.5 mm larger than the nominal diameter of the bolt Larger or slotted holes will not be permitted unless otherwise indicated?

(iv) Long Grips:

Additional high-strength bolts are not required for long grips.

(v) Installations:

- a. The turn-of-nut tightening or calibrated wrench tightening methods, as specified in the AISC Specification for Structural Joints Using ASTM 325 Bolts, shall be used. The use of a direct tension indicator for tightening will not be permitted.
- b. The minimum projection of the installed bolt beyond the nut shall be 6 mm.
- c. The threaded part of the installed bolt shall not be in the shear plane.
- d. Re-use of torque bolts will not be permitted.

**(3) Shop Cleaning and Painting**

- a. Shop cleaning and painting including surface preparation of structural steel shall conform to all applicable requirements of Specification Section 6500 "Painting".
- b. Painted surfaces of structural steel will be inspected, as specified in the specification Section 6500 "Painting" in the field after a reasonable period of weathering.
- c. If the condition of any surface indicates insufficient thickness of paint was used, or method application was incorrect, etc. (regardless of prior approval of the work in the shop), Contractor shall repaint all such surfaces in the field as requested.
- d. The foregoing requirement shall not apply with respect to surfaces abraded in shipping, handling etc. for which field touch-up painting will be performed by the Contractor.

**(4) Product Handling and Delivery**

The Contractor shall arrange for corresponding parts of each unit manufactured from the drawing to be interchangeable as far as economic manufacturing conditions permit and shall advise the Engineer of the precise arrangements made in this respect.

Members shall have approximate mass (weight), erection plan number and, where applicable, match marks metal stamped (incised) thereon, circled in epoxy paint for easy visibility. Structural steel shall be delivered in the sequence indicated on the accepted shop drawings.

Structural steel and accessories shall be bundled, crated, fitted with blocks or boxed, as applicable, for sea transportation so that damage incident to such mode of transportation does not occur. Sections not suitable for hold transport shall be suitably prepared for deck transport.

**6307 Workmanship**

**(1) Erection of Structural Steel**

Erection of structural steel shall conform to all requirements of the AISC Manual of steel

construction and the following:

(a) Lines and Grades

The Contractor shall layout lines and grades from existing base lines and bench marks on the property, and shall be fully responsible for the correctness of these lines and grades and for proper execution of the Work to these lines and grade.

The Engineer reserves the right to verify the correctness of these lines and grades during the progress of the Work. This verification by the Engineer will not relieve the Contractor of any responsibility for the Work.

The Contractor shall preserve and maintain all benchmarks and reference points established. Should the Contractor, during execution of the Work, destroy or remove any bench marks and/or reference points established by the Employer, the cost for re-establishing these bench marks and/or reference points will be charged to the Contractor.

(b) Erection Tolerances

Steelwork shall be set accurately to the established lines and grades and shall be plumbed and leveled such that the deviations in all completed work are within the tolerance limits and meet the requirements, as specified in the AISC Code of Standard Practice and this Specification. Anchor bolts shall be set at the specified lines and elevations within the tolerance of  $\pm 1.5$  mm related to the relevant base plate.

**(2) High Strength Bolting**

(a) Type of Connection

FRICITION-TYPE Connection, as specified in the AISC Manual and the "Specification for Structural Joints Using ASTM A325 Bolts or A490 Bolts" or approved equal shall be used for all bolted connection unless otherwise indicated.

(b) Type of Bolts

The following types of high-strength bolts shall be used unless otherwise indicated. ASTM A325 Type 1 or approved equal for all bolt sizes through 22 mm diameter. For other size bolts, the types of bolts indicated on the contract drawings/shop drawings.

(c) Assembly of Joints

(i) Method of Installation

The Turn-of Nut Tightening or Calibrated Wrench Tightening method, as specified in the AISC "Specification for Structural Joints Using ASTM A325 Bolts or A490 Bolts", or approved equal shall be used.

(ii) Bolt and Nut Assembly

All nuts shall be fully engaged with a minimum of 6 mm projection of the installed bolt beyond the nut. The threaded part of the installed bolt shall not be in the shear plane. Reuse of bolts as specified in the AISC Specification for Structural Joints will not be

permitted.

**(iii) Fairing-Up**

The Contractor shall fair up the holes in each connection with enough pins to maintain the dimensions and plumpness of the structure. These pins shall remain in place until all bolts in the balance of the holes have been tightened.

**(iv) Washers:**

- a. For an A325 bolt, a hardened flat washer shall be used under the bolt head or under the nut, whichever is to be turned in tightening.
- b. Beveled Washers shall be used as specified in the AISC Specification for Structural Joints Using A325 Bolts.

**(v) Location of Bolt Heads**

- a. Columns: On outside faces of flanges.
- b. Beams and Girders: On upper sides of flanges

**(3) Field Cleaning and Painting**

After erection is completed, Contractor shall clean and field touch up and field finish paint all structural steel, gallery steel and surge bins etc. in accordance with the requirements of Specification Section 6500 "Painting" unless otherwise indicated.

**6308 Inspection and Examination**

**(1) General**

The Contractor shall retain, and pay for, the services of a Testing Laboratory or Inspector(s) to perform this inspection and examination work. The Contractor shall provide, and pay for, all rigging required for the Work and for all personnel required assisting the Inspector (s).

**(2) Testing on Site**

During erection the Contractor shall carry out all necessary inspection checks and tests at suitable intervals in order to guarantee safety on the Site under the given conditions of erection and the orderly execution of the erection in accordance with the Specifications, the drawings and the erection regulations. After final erection of the structure, the Contractor in the presence of the Engineer shall carry out inspections, checks and tests, in order to demonstrate the completeness of the Works, the correctness values. To facilitate inspections and maintenance, the structures shall be provided with steps, ladders handrails, screens, guard and other facilities in approved positions. The Contractor shall provide for Engineers use the following equipment for inspecting the tightening of high strength bolts:



Item No.	Item	No. Required
1.	Bolt tension calibrator with gage indicating actual bolt tension.	2
2.	Torque type inspecting wrenches	2
3.	Power type inspection wrenches	2
4.	Whitener multi-position strain gage with accessories (Soil test, Inc. T-171 or equivalent)	1
5.	Any other testing equipment required for above work	1 each

### 6309 Quality Assurance/Quality Control (QA/QC)

#### (1) QA/QC procedures

- a. Design required for shop drawings
- b. Welding, including, non-destructive testing
- c. Shop tests and inspection procedures
- d. Cleaning and painting
- e. Packaging and shipping
- f. Installation procedures, tolerances
- g. Erection checks
- h. Commissioning, testing and cleaning

#### (2) QA/QC documentation:

- a. Material certificates (mill reports)
- b. Shop tests and inspection reports
- c. All other documentation required by applicable Codes and Standards.
- d. Welding procedures and inspection reports

### 6310 Measurement and Payment

Measurement for payment for design, fabrication and erection of structural steel will be on the number of metric ton of structural steel, furnished and installed as shown on the drawings. Those Unit Prices shall include all materials including welds and bolts, fabrication, welding, coating, testing work, shop and field finish painting, labor, transportation, erection and other works required for completion of the structural steel works. The weight of welds and bolts shall not be included in the calculated weight submitted for payment. Payment for structural steel will be made at the contract Unit Price per metric ton of structural steel fabricated and erected.

## **SECTION 6400 GALLERY WORKS**

### **6401 General**

#### **(1) General**

This Section shall covers all gallery works in the building

#### **(2) Scope of Works**

The Contractor's scope of work shall include design, manufacture, and delivery to Site and installation required for the Gallery Work. The works shall include but not be limited to the following:

- a. Checkered plates
- b. Handrails
- c. Ladders.
- d. All brackets, hangers and bracing necessary to support the Work rigidly and keep it free from vibration and excessive deflection.

### **6402 Applicable Codes and Standards**

The codes and standards of the following organizations are specifically applicable to the design, manufacture and testing of the work covered by this specification:

ASTM	American Society for Testing and Materials
AISC	American Institute of Steel Construction Manual
AWS	American Welding Society
SSPC	Steel Structures Painting Council, USA
SAE	Society of Automotive Employers, USA
UBC	Uniform Building Code of USA
BS	British Standards
JIS	Japan Industrial Standards
OSHA	Occupational Safety and Health Administration, USA

Code Requirements: All stair riser heights, stair tread depths, stair widths, ladders, ladder guards, hand-railing heights etc. shall conform to the latest UBC or approved equal and OSHA code requirements that may apply.

### **6403 Submittals**

#### **(1) Shop Drawings**

Copies of shop drawings showing complete details of fabrication of all gallery works and accessories including plan views, elevations, sections, details and fastening methods for this complete scope of works. The shop drawings shall be prepared in conformity with the best modern practice and with due regard to economy in fabrication and erection.

## **(2) Test Reports and Certificates**

The Contractor shall make copies of material certificates, mill test reports and other test reports required by applicable codes or standards available. Those reports shall be submitted on request to the Engineer after completion of the tests.

## **(3) Qualification Reports**

Copies of welding qualification reports, quality control reports, and other reports as specified or required shall be furnished by Contractor to the Engineer, during execution or upon completion of the Work.

## **(4) As-Built Drawings**

Upon completion of the work the Contractor shall submit as-built drawings.

# **6404 Materials and Workmanship**

## **(1) Workmanship, Sequence and Finish**

- a. Workmanship and finish shall be equal to the best shop and field practice. All material shall have clean surfaces before being worked. Fabricated members shall be free from twists, bends or open joints. Shearing and clipping shall be neatly and accurately done. All work shall be neatly finished.
- b. As much of the Work as possible, including connections and joints between members, attachment of clip angles, punching of holes etc. shall be shop fabricated so as to reduce the amount of field erection work to a minimum.
- c. The Contractor shall be responsible for proper fit of all materials furnished, including railing and post clearance with other equipment, piping, grating, checkered plate etc. including field check for clearances.
- d. On existing installations where gallery work is to be added or modified, the Contractor shall take field measurements to verify connections of new work to work in place. All such field measurements shall be taken prior to fabrication and shall be clearly marked and identified as such on the shop drawings.
- e. The Contractor shall fabricate and erect the gallery works in the sequence desired by the Engineer if requested.

## **(2) Materials**

- a. Structural steel and all other steel including floor plates, ladders, cages, guard plates etc. shall conform to applicable requirements of ASTM A36 - Standard Specification or approved equal for Structural Steel.
- b. Bolts shall be of ASTM A325 Type 1 steel or approved equal.
- c. Handrails and posts shall be butt-welded steel pipe of standard weight (Schedule 40) or steel structural tubing of equal or greater weight unless galvanized pipe is called for in the

Specification. The pipe shall conform to ASTM A120 or approved equal with its steel meeting a minimum tensile strength of 3000 kg/cm<sup>2</sup> and a yield point of 1750 kg/cm<sup>2</sup> on actual physical tests. The structural tubing shall conform to ASTM A501, F-36 or approved equal. See the standard drawings for recommended maximum spacing between handrail posts. Contractor shall retain final responsibility for the spacing of handrail posts. All handrails shall be shop prime and field finishes painted.

## **6405 Design Requirements**

### **(1) Handrails**

Handrail shall be provided for the following areas and where required:

- a. Around every stairway floor opening.
- b. Around every floor opening into which a person can walk except when provided with an opening cover.
- c. On all flights of stairs having four or more risers.
- d. Around every open-sided floor, walkway, platform.
- e. Adjacent to dangerous equipment
- f. All temporary openings shall be guarded by temporary handrails.
- g. Handrails shall be placed at 1050 mm above the floor level.
- h. Handrails of stairs shall be placed not less than 700 mm nor more than 1100 mm above the nosing of treads. They shall be continuous the full length of the stairs. Ends shall be returned or shall terminate in newel posts or safety terminals.
- i. Handrails shall be as per standard drawings and welded construction. The handgrip portion of handrails shall have a continuous smooth surface with no sharp corners.
- j. Handrails projecting from a wall shall have a space of not less than 40 mm between the wall and the handrail.

### **(2) Ladders**

Ladders shall be provided in all pits, manholes, entrances to tunnels, to all roofs over 6 m above the ground where there is no access by a stair, or to the floors where no stair system is provided. The following types of ladders shall be used in the design of a power plant:

- a. Ladders, which consist of individual round, steel rungs.
- b. Ladders, which consist of, steel side rails and steels rungs attached to side rails.
- c. Ladders Equipped with a Cage.

Ladders of 5.0 m or more shall have a safety cage starting at maximum 3.0 m above ground or platform level. Landings or platforms shall be provided at maximum 9.0 m spacing.

## **6406 Detailed Requirements**

### **(1) Checker Steel Floor Plates**

- a. Checkered steel floor plate shall be rolled steel galvanized plate of a type and design suitable for the floor loading. Steel floor plates shall have a nominal thickness of 6 mm unless otherwise required.

- b. The pattern centerlines on all checkered steel floor plate sections shall match and line up in both directions on adjacent sections.
- c. All floor plate sections shall fit snugly into place with not more than 1.5 mm space between.
- d. All steel floor plates shall be amply reinforced by means of steel angles along all edges of each plate and in intermediate locations where necessary. Each stiffener shall be welded to underside of plate along both edges of the stiffener. Each section shall be provided with two lifting holes located in opposite corners. Floor plates shall be straight and flush with the surrounding floor. Each floor plate section shall be provided with grinding bars, for aligning faces of plate sections with each other and with adjacent flooring. Grinding bars shall have bearing over their entire area.
- d. Steel floor plates, where curb angle construction is required shall also be reinforced with stiffeners except for narrow trenches where stiffeners may not be required.
- e. All openings for pipes shall be neatly cut so as to clear the pipe (or pipe covering) 12 mm all around. The arrangement shall be such that any section can be readily removed.

## **(2) Handrails**

- a. All railings and railing post connections shall be in accordance with the details shown for each condition on the standard drawings.
- b. All railing and post intersections shall be welded. Pipe or tubing posts shall be welded to the top rail, the rail being continuous.
- c. The center rail shall be welded to the posts, the posts being continuous.
- d. The railing and post sections shall be completely fabricated in the shop in as large sections as is practicable and that can be conveniently handled and erected. Field railing splices where required shall be welded and shall in all cases be located near a pipe post or point of support. No screwed couplings will be permitted in rails or posts.
- e. After shop and/or field welding is done, all rough weld metal projections shall be neatly ground off so that the joint will present a smooth appearance. Neat appearing welds with no rough projections will not require grinding. All sharp corners shall be rounded.
- f. The Contractor shall cut handrails and guard plates and weld them (except galvanized steel) in field to clear diagonal bracing where required.
- g. Ends of handrails at building columns or other vertical steel may be attached to the steel by means of a collar welded to the steel.
- h. Where gates are required, swing gates, shall be provided. No chain gate shall be used.

## **(3) Ladders**

- a. Ladders shall be galvanized and made of steel bar stringers and round steel bar rungs as shown on the standard drawings.
- b. Suitable guards or cages shall be furnished for ladders for locations and conditions stated in Sub-Section 6405 (2) or where required OSHA or UBC. Guards shall be of type and design as shown on the standard drawings or as required by these codes.
- c. Access from platforms, floors or landings to all ladders going to a lower elevation shall be provided with a pipe swing gate, as may be indicated or as may be required by OSHA or UBC.

- d. Arrangement and details of ladders, cages, swing gates etc., shall conform to the applicable details shown on the shop drawings approved by the Engineer.

#### **6407 Fabrication and Erection**

Fabrication and erection shall be in accordance with the applicable provisions of the AISC Manual of Steel Construction (latest edition) and the following:

##### **(1) Shop Connections**

- a. All shop connections shall be made by welding or with bolts.
- b. Welded connections shall conform to Tables III and IV, "Framed Beam Connections", of the AISC Manual, using E70XX electrodes or approved equal unless otherwise indicated. The connection angle length shall be the maximum for each size beam.
- c. Bolted connections shall conform to Table IIA, "Framed Beam Connections", of the AISC Manual, using double angle connections with minimum 19 mm diameter bolts of ASTM A325 Type 1 or approved equal for friction-type connections unless otherwise indicated. Number of bolts and connection angle length shall be the maximum for each size beam. The minimum projection of the installed bolt beyond the nut shall be 6 mm.

##### **(2) Bearing Plates**

Beams bearing on masonry or concrete work shall be provided with bearing plates and clip angles.

##### **(3) Fabrication**

Structures shall be plumbed or leveled such that the deviations for the complete work do not exceed the requirements of the AISC Code of Standard Practice or approved equal. Erection drawings shall be marked accordingly.

##### **(4) Welding**

Welding shall be in accordance with the applicable provisions of the AISC Manual, AWS D1.1, "Structural Welding Code".

##### **(5) Cleaning and Painting**

- a. Shop cleaning and painting of gallery steel shall be in accordance with Specification Section 6500.
- b. The field finish coat of paint for surfaces other than grating, ladder stringers and bar rungs shall be applied as per Specification Section 6500.

##### **(6) Galvanizing**

- a. Ladders (except cages), floor plates and stop bars shall be complete shop fabricated and

galvanized after fabrication unless noted otherwise. The galvanizing shall be compatible to the environmental conditions.

- b. All parts to be galvanized shall be designed for erecting with bolts, pins, anchor bolts, clips etc. and shall not require field welding, field riveting, field drilling or any operation that would damage galvanizing.
- c. All bolts, clips, nuts, washers, anchors, stops, banding and other appurtenances required for galvanized parts shall also be galvanized or stainless steel and shall be furnished and installed by Contractor.
- d. Galvanizing shall conform to the applicable requirements set forth in the latest editions of the ASTM Standard Specifications A123, A153, A384, A385 and A386 or approved equal.
- e. Bolts shall be galvanized after threading. Nuts shall be galvanized before threading. Members which are being punched or drilled shall be galvanized after punching or drilling.

#### **6408 Quality Assurance/Quality Control (QA/QC)**

##### **(1) General**

Quality assurance/control procedures shall include the requirements defined in this specification but not be limited to, and aspects such as the following.

- a. Prepare shop drawings
- b. Welding incl. non-destructive testing
- c. Shop tests and inspection procedures
- d. Cleaning and painting
- e. Packaging and shipping
- f. Installation procedures, tolerances
- g. Erection checks
- e. Commissioning, testing and cleaning

##### **(2) QA/QC**

The quality assurance/control documentation shall include but not be limited to the following:

- a. Material certificates (mill reports)
- b. Welding procedures and inspection reports
- c. Shop tests and inspection reports
- d. All other documentation required by applicable Codes and Standards.

#### **6409 Measurement and Payment**

##### **(1) Handrails and Ladders**

- a. Measurement for payment for handrails will be made by the length in meters and measurement for payment for ladders will be made on kilogram (kg) of ladder fabricated, furnished and installed as calculated from the approved shop drawings.
- b. The unit price shall include the cost of handrail posts, top and intermediate rails, ladder cage, side rails and rungs, and coating of the handrails and ladder. Payment for handrails

will be made at the contract unit price per linear meter and payment for ladder will be made at the contract unit price per kg.

**(2) Other Items**

- a. Measurement for payment other structural steel items will be on the number of ton of structural steel, furnished and installed as shown on the approved shop drawings.
- b. The unit price shall include the costs of materials, fabrication and coating.



## **SECTION 6500 PAINTING**

### **6501 General**

#### **(1) General**

This Section shall covers all painting works in the building.

#### **(2) Scope of Works**

The Contractor's scope of work shall include design, manufacture, and delivery to Site and installation required for the Painting. The works shall include but not be limited to the following:

- a. Supply of all material and labor to apply shop and field painting on structural steel, gallery steel, miscellaneous steel, auxiliary steel, equipment and others
- b. Surface preparation for shop and field painting
- c. Shop painting including prime, intermediate and finish coats as required
- d. Field painting including prime, intermediate and finish coats as required
- e. Field touch-up painting

### **6502 Applicable Codes and Standards**

The codes and standards of the following organizations are specifically applicable to the design, application and testing of the work covered by this Specification.

SSPC Steel Structure Painting Council, U.S.A.

#### **(1) Preparation Methods**

SSPC - SP1 - Solvent Cleaning,  
SSPC - SP2 - Hand Tool Cleaning,  
SSPC - SP3 - Power Tool Cleaning,  
SSPC - SP10 - Near-White Blast Cleaning,

#### **(2) Paint Application**

SSPC - PA 1 "Shop Field and Maintenance Painting"  
SSPC - PA2 "Measurement of Dry Film Thickness with Magnetic Gages"

### **6503 General Requirements**

#### **(1) Safety Requirements**

All safety measures and precautions required by Engineer and safety recommendations of

materials manufacturers, suppliers, etc. shall be carefully complied with during the entire course of the Work.

## **(2) Paint**

- a. Paint manufacturers Instructions: The manufacturer of the paints for the selected system shall submit through Contractor printed instructions for the use his materials. Where such instructions take exception to this specification, the exception shall be submitted to the Engineer.
- b. Paint shall be as made by the manufacturer's hereinafter specified or approved equivalent and shall be delivered to the place of use in unbroken containers bearing manufacturer's brand name and number.
- c. Paint identification numbers are paint manufacturer's numbers and shall be used in ordering paint.
- d. Paint shall not be mixed or stored in contaminated containers. All paint shall be thoroughly mixed before using and shall be applied in strict accordance with the manufacturer's printed instructions. The mixture of paint shall be prepared at the shop or point of use.

## **(3) Technical Requirements**

### **(a) General**

- a. Paints, including types, colors, products and manufacturers shall be approved equal and be suitable for the environmental conditions. Use of all components of the same manufacturer's system is mandatory.
- b. Paints shall be delivered to the place of use in unbroken containers bearing the paint manufacturers brand name and identification number.
- c. Each coat of paint shall be of a different discernible color.
- d. Most of the surfaces shall receive the field finish painting.

## **(4) Submittals**

The Contractor shall submit the following to the Engineer for review and approval before commencement of the relevant item of finishing work.

- a. Manufacturer's literature, giving a materials description, color charts, preparation of the background and range of accessories together with recommendations for good workmanship practice.
- b. Samples of each type of finish from the manufacturers or Contractor produced range as requested by the Engineer to enable the selection of color, pattern and the like.
- c. Sample panels of each type of finish mounted on the correct background in accordance with the specification. Sample panels shall be a minimum 600 x 600 mm or a sufficient size, in the opinion of the Engineer, to enable him to assess and establish the quality of workmanship. The Contractor must obtain the approval of the Engineer concerning quality, application, jointing, evenness, movement joints and workmanship before

work commences. No subsequent work, which is substandard to the approved sample panel, shall be accepted.

- d. Data sheets and specifications from the appropriate paint manufacturer, for the storing, preparation, mixing and application of the paint material.

## **6504 Specified Surface Classes**

### **(1) General**

The Specified Surface Classes and the general nature of the specified surfaces included in each class, shall conform to the requirements specified herein.

### **(2) Classes**

The specified surfaces included in the Work consist of the following four classes. Class SBS (Specified Building Surfaces): Includes all exposed surfaces of the following as applicable.

- a. Plastered surfaces
- b. Interior doors, rolling doors
- c. Ornamental handrails
- d. Wood work

## **6505 Painting Work System**

### **(1) Painting Schemes**

The following tables of ANNEX 1, ANNEX 2A, ANNEX 2B and ANNEX 2C show the Engineer's suggested paint systems, for steel and building surfaces respectively.

### **(2) Compatible Paints**

The Contractor shall design the paint system to be compatible with the material to be coated, the temperature of the structures/equipment/piping surfaces, service conditions and which can best resist the tropical conditions and salty air environmental.

### **(3) Painting Systems Proposal**

The Contractor shall submit with his bid proposal details of painting system and additional surface preparation requirements in for Engineer's review.

## **6506 Details of Painting Work System**

### **(1) Detailed Requirements for Painting**

#### **(a) Shop Prime Painting**

##### **(i) Extent**

Extent of surfaces to be painted and to be left unpainted in shop after completion of the surface preparation shall be as indicated in ANNEX 1 table.

##### **(ii) Machinery Painting**

Milled surfaces and other machine-finished surfaces shall be protected against corrosion prior to shipment by using lacquer, unless otherwise indicated.

#### **(b) Field Prime Painting**

Extent of field prime painting shall be as indicated in ANNEX 1 table.

#### **(c) Field Touch-up Painting**

##### **(i) Requirements**

- a. Field touch-up painting shall consist of one prime coat and one intermediate coat of paint applied to the following surfaces after completion of specified surface preparation.
- b. Surfaces where the shop coat of paint has been marred, scratched or otherwise damaged, due to shipping, handling, erection, installation, weathering etc.
- c. Bolt heads, nuts, washers, and adjacent surfaces left unpainted in the shop.
- d. Surfaces of field welds, and adjacent surfaces left unpainted in the shop.
- e. Surfaces of any ferrous fasteners not otherwise protected.

##### **(ii) Exposed Fabrication Painting**

Exposed fabrications, erection of shipping marks shall be cleaned off and the areas touch-up painted to match the adjacent surfaces.

##### **(iii) Two Coats Painting**

For any surfaces, which have received two coats, field touch-up painting shall consist of two coats also as indicated in ANNEX 1 table.

## **6507 Method of Application**

The method of application shall be governed by the paint manufacturer's recommendation for the particular paint being applied. Application of the paint shall primarily be made with proper size and grade of brushes except where spray equipment or rollers can be used to advantage.

Spray equipment, if used, shall be accurately and fully controlled at all times so as to prevent damage to adjacent surfaces. In the opinion of Engineer, the overspray during paint spraying operations is causing damage to plant equipment the use of spray equipment will be

restricted to those areas (if any) where, in the opinion of Engineer, damage to plant equipment will not occur.

Contractor shall solvent clean or sand and smooth touch-up, prime coats and undercoat painting on all equipment and on other readily visible surfaces to secure a smooth workmanlike finish coat.

## **(1) Performance**

### **(a) Paint Application**

#### **(i) Temperature Restrictions**

Paint shall not be applied when the surrounding air temperature is below 5°C, nor when the temperature is expected to drop to 0°C, nor when the temperature is expected to drop to 0°C before the paint dries. Paint shall not be applied to steel which is more than two degrees below the surrounding air temperature, or which is at temperature lower than 3°C. Paint shall not be applied to steel which is at a temperature of over 50°C unless the paint is specifically formulated for application at that temperature. When steel is painted in hot weather, precautions shall be taken to ensure that the specified dry film thickness of paint is achieved.

#### **(ii) Moisture and Humidity Restrictions**

Paint shall not be applied where exposed to rain, snow, fog, or mist, or when the relative humidity is such as to cause condensation of paint on metal surfaces due to variation in metal temperatures and surrounding air temperatures. All surfaces shall be perfectly dry before and while being painted and for 24 hours after painting.

#### **(iii) Method of Application**

Application of paint shall primarily be made by using proper size grade of brushes, except where spray equipment or rollers can be used to advantage. Spray equipment, if used, shall be accurately and fully controlled at all times so as to prevent damage to adjacent surfaces. Where two or more coat work is specified, the following shall apply:

- a. The second coat of paint shall not be applied until the prime coat has been completed and checked. If the second coat is applied before the check of the prime coat, it will be assumed that the prime coat has not been applied, and at the option of the Engineer, the entire painting shall be removed and the area repainted from the beginning.
- b. Sufficient time for drying shall be allowed between coats.

#### **(iv) Minimum Thickness of Paint**

The prime coat and second coat of paint shall be applied so as to result in a minimum dry film thickness as specified in ANNEX 2 tables. The paint manufacturers shall accordingly be required by the Contractor to furnish the Contractor with the wet film thickness required, for each type of paint and method of application, to obtain the specified dry film thickness. These wet film thickness shall be based on applying the paint directly from the original containers with no thinners added.

If the Contractor intends to use thinners, he shall inform the Engineer and the paint manufacturer of his intended method of application. The paint manufacturer shall then re-evaluate the paint and furnish the Engineer and the Contractor with the new wet film thickness required.

#### **6508 Inspection**

All the Work covered by this Specification will be subject to inspection by the Engineer, and any work found not in accordance with the Specification shall be satisfactorily redone by the Contractor with no cost to the Engineer. Dry and wet film thickness may be determined by the use of gauges. The gauges and procedure shall be in accordance with SSPC PA-2. The surface temperature may be determined by the use of a surface thermometer. All equipment necessary for quality control testing shall be provided by the Contractor when requested by the Engineer.

#### **6509 Quality Assurance/Quality Control (QA/QC)**

The QA/QC procedures shall include the requirements defined in this specification and shall include.

- a. Packaging and shipping
- b. Field cleaning and painting procedures

#### **6510 Method of Measurement and Payment**

The Costs of all painting works, including supplying of materials and deemed to be included in the prices of the structured steel, galleries such as ladders, handrails and doors except for the items listed in the following:

Separate payment will be made for painting works on the following surfaces:

- a. Concrete walls and ceilings
- b. Plastered walls

Measurement will be made per square meter of wall or/and ceiling surface plastered or in concrete.

**ANNEX 1 EXTENT OF PRIME COAT AND RELATED PAINTING**

Item	Surface Preparation	Painting	Paint System (See Annex 2A)
1. Structural and Miscellaneous Ferrous Steel Members.	SIS - SA 2½ - 3		
a. All steel surfaces unless otherwise indicated.	Solvent and Near White Blast Cleaning.	1 shop prime coat of paint, 1 shop intermediate coat	440-A
b. Inaccessible steel surfaces and girts.	Solvent and Near White Blast Cleaning.	1 shop prime coat and 2 shop intermediate coats of paint	440-A for prime coat and 440-B for second coats
c. Milled, embedded, contact and welded surfaces, etc. :			
c.1 Milled and machined surfaces (as on base plates).	None (Unless otherwise indicated herein)	No painting (Milled surfaces protected with lacquer. All other surfaces protected with anti-rust compound unless otherwise indicated herein)	
c.2 Anchor bolts, bolts, nuts.	Rust Removed		
c.3 Embedded surfaces.	Solvent and Near White Blast Cleaning.	1 shop prime coat paint.	440-A

## ANNEX 2A PAINT SYSTEMS

System Designation	Type/Colour of Paint	Use	Thickness	Paint Products/ Manufacturers
440 - A	- Inorganic Zinc (85 to 89% Zinc by weight)  - Zinc dust primer, 2 component base epoxy resin	Prime coat for Steel	1 x 60 to 75 microns dry film thickness  1 x 50 microns	1. Dimetcoat 9/ Ameron. 2. Zinc Clad (B 69V1/B69D2)/Sherwin-Williams) 3. ICI Zinc Galvanize 6 (R565-95/R867-94) 4. Approved equal
440 - B	-Two component polyamide epoxy Carboline  -Micaceous iron oxide point, 2-component base epoxy resin	Intermediate coat for steel	1 x 125 to 175 microns dry film thickness  1 x 80 microns	1. Amercoat 383 HS/ Ameron 2.Val-Chem epoxy (89 series/ Valspar Corp. 3. HS Epoxy (B62 Series/ B60V20)/ Sher-Williams 4. ICI Epoxy Bildcote (R580-Line/ R275-81) 5. Approved equal
440 - C	Alkyd paint/ brown	Prime coat for steel or aluminum.	50 microns dry film thickness each coat.	1.500 Prime Rite/Detroit 2.67-Y-746/E.1. Du Pont de Nemours & Co. 3. ICI Q.D. Red Lead Primer R540-140. 4. Approved equal.
440 - D	Alkyd paint/ black	Second coat, unless otherwise indicated.	50 microns dry film thickness.	1.# 30 Superior Graphite Paint/Detroit Graphite Co. 2.96-67640/ duPont de Nemours & Co. 3. ICI Super-structure Finish R350-122 black. 4. Approved equal.
440 - H	Two component epoxy mastic primer.	For steel surfaces where blast cleaning is not practical.	125 to 175 microns dry film thickness.	1. Amerlock 400/ Ameron. 2. Alumepoxy 75A2/Valspar Corp. 3. Epoxy Mastic B62 SW1/B60 VW1/Sher-Williams. 4. ICI Epoxy Bild-code (R580-Line/R275-81). 5. Approved equal.

Names of paint products / manufacturers as specified in each paint system are for reference only. Any equivalent local products proposed by the Contractor are subject to approval by the Engineer.



**ANNEX 2B PAINT SYSTEM FOR STEEL SURFACES**

Specs. No.	External Conditions	Surface Preparation	Paint System	Nominal Dry Film Thickn. (in mm)
1	<p>Inside of buildings</p> <p>Exposed to dry or moist salty air</p> <p>For temperatures up to 60°C</p>	SA. 2½ - 3	<p><u>Prime Coat :</u> 1x zinc dust primer (2-component) Base : Epoxy resin</p> <p><u>Intermediate Coat :</u> 1 x micaceous iron oxide paint (2-component) Base : Epoxy resin</p> <p><u>Finish Coat :</u> 2 x enamel paint Base : Chlorinated rubber or acrylic resin</p>	<p>1 x 0.050</p> <p>1 x 0.080</p> <p>2 x 0.050</p>
2	<p>Inside of buildings</p> <p>Exposed to dry or moist salty air</p> <p>For temperatures up to 120°C</p>	SA. 2½ - 3	<p><u>Prime Coat :</u> 1 x zinc dust primer (2-component) Base : Epoxy resin</p> <p><u>Intermediate Coat :</u> 1 x micaceous iron oxide paint (2-component) Base : Epoxy resin</p> <p><u>Finish Coat :</u> 2 x enamel paint Base : Alkyd resin</p>	<p>1 x 0.050</p> <p>1 x 0.080</p> <p>2 x 0.040</p>
3	<p>Encased in concrete</p>	SA. 2½ - 3	<p><u>Prime Coat :</u> 1x zinc dust primer (2-component) Base : Epoxy resin</p> <p><u>Intermediate Coat:</u> 1 x micaceous iron oxide paint (2-component) Base : Epoxy resin</p> <p><u>Finish Coat :</u> Not required</p>	<p>1 x 0.050</p> <p>1 x 0.080</p>

Specs. No.	External Conditions	Surface Preparation	Paint System	Nominal Dry Film Thickn. (in mm)
4	Exposed to weather  Dry or moist salty air  For temperatures up to 60°C	SA. 2½ - 3	<u>Prime Coat :</u> 1 x zinc dust primer (2-component) Base : Epoxy resin <u>Intermediate Coat :</u> 1 x micaceous iron oxide paint (2-component) Base : Epoxy resin <u>Finish Coat :</u> 2 x enamel, micaceous iron oxide paint, coloured Base : Epoxy (2-component) or acrylic resin	1 x 0.050   1 x 0.080   2 x 0.80
5	Exposed to weather  Dry or moist salty air For temperatures up to 120°C	SA. 2½ - 3	<u>Prime Coat :</u> 1 x zinc dust primer (2-component) Base : Epoxy resin <u>Intermediate Coat :</u> 1 x micaceous iron oxide paint (2-component) Base : Epoxy resin <u>Finish Coat :</u> 2 x enamel, micaceous iron oxide paint, coloured Base : Epoxy resin (2-component)	1 x 0.050   1 x 0.080   2 x 0.080
6	Exposed to condensing Water	SA. 2½ - 3	<u>Prime Coat :</u> 1 x zinc dust primer (2-component) Base : Epoxy resin <u>Intermediate Coat :</u> 1 x micaceous iron oxide paint	1 x 0.050

Specs. No.	External Conditions	Surface Preparation	Paint System	Nominal Dry Film Thickn. (in mm)
			(2-component) Base : Epoxy resin <u>Finish Coat :</u> 2 x enamel, micaceous iron oxide paint, coloured Base : Epoxy (2-component) or acrylic resin	1 x 0.080  2 x 0.080
7	Exposed to gasoline, diesel fuel or various oils below 60°C	SA. 2½ - 3	<u>Prime Coat :</u> 1 x zinc dust primer (2-component) Base : Epoxy resin <u>Intermediate Coat :</u> 1 x micaceous iron oxide paint (2-component) Base : Epoxy resin <u>Finish Coat :</u> 2 x enamel paint (2-component) Base : Epoxy resin	1 x 0.050  1 x 0.080  2 x 0.080
8	In the ground, exposed to salty soil. For temperatures below 60°C	SA. 2½ - 3	<u>Prime Coat :</u> 1 x zinc dust primer (2-component) Base : Epoxy resin <u>Intermediate Coat :</u> 1 x micaceous iron oxide paint (2-component) Base : Epoxy resin <u>Finish Coat :</u> 3 x tar-epoxy resin (2-component) or 2 x polyurethane-tar (2-component)	1 x 0.050  1 x 0.080  3 x 0.300  2 x 0.500

## ANNEX 2C PAINT SYSTEM FOR BUILDING SURFACES

### (Interior Walls)

ITEM	Coating	Coat Type	DFT* microns
1.	Prime Coat	Dulux Acrylic Wall Primer Filler	Subject to the surface conditions
2.	Intermediate Coat	Dulux Emulsion Paint Finish	25-40
3.	Finish Coat	Dulux Emulsion Paint Finish	25-40

### (Exterior Walls)

ITEM	Coating	Coat Type	DFT* microns
1.	Prime Coat	Dulux Textaclad Primer	80
2.	Intermediate Coat	Dulux Textaclad Semi Gloss Finish	40
3.	Finish Coat	Dulux Textaclad Semi Gloss Finish	40

DFT: Dry Film Thickness

Notes:

1. Names of paint products / manufacturers as specified in each paint system are for reference only. All materials and system proposed by the Contractor are subject to approval by the Engineer.
2. All paints shall meet the performance requirements.
3. The use of all components of the same manufacturer's paint system is mandatory.
4. The Engineer will select the color scheme of field finish painting work to complement the building colour at a later date after the award of the Contract at no extra cost to the Engineer.