



Project Title: Design, Supply, Installation, Testing & Commissioning of Fire-fighting system and associated facilities including Operation & Maintenance for a period of five years as per OISD-156 at Oil Jetty No. 08, Kandla, of Deendayal Port Authority

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TECHNICAL SPECIFICATIONS FOR STRUCTURAL WORKS

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SECTION-1: DESCRIPTION OF WORK



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1.1 The technical specifications for structural steel works furnished herein are intended as guidelines for execution of the works satisfying the Purchaser's requirements and also complying with all technical norms. This specification is to cover preparation of scheme drawings for rectification, modification & strengthening of existing structures, dismantling & removal of steel structures, preparation of design calculations, detail engineering including design drawings, fabrication drawings and getting approval from consultant of design calculations, drawings & schemes for modification, rectification or dismantling, scheme for temporary support for existing pipe line or other loads supported on existing structure, erection procedure, including procurement of raw steel, fabrication & supply, erection, painting of existing structures, painting of rectified & refurbished structures, painting of new structures, procurement and supply of sheeting, finishing and handing over of all steel structural work on a turnkey basis for the Project / Works including all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.

1.2 Description of various items of work under this specification and nature of work in detail are given hereinafter. The complete work under this scope is referred to as STRUCTURAL WORKS. The detailed scope of works covered under Structural works is given in Section -2.

1.3 The work to be performed under this specification consists of preparation of scheme drawings for rectification & modification of existing structures, dismantling of steel structures, preparation of design calculations, detail engineering including design drawings, fabrication drawings and getting approval from consultant of design calculations, drawings & schemes for modification, rectification or dismantling, procurement of raw steel, fabrication & supply, erection, painting of existing structures, painting of rectified & refurbished structures, painting of new structures, procurement and supply of sheeting, finishing and handing over of all steel structural work on a turnkey basis for the Project / Works including all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.

1.4 Supply of all materials including structural steel, fasteners, paints, consumables like gas, electrodes, temporary supports for rectification & dismantling works, etc. and all other materials as deemed necessary for proper completion of the work, are included in the scope of the Contractor.

1.5 Fabrication activity shall be carried out outside the plant premises, unless allowed otherwise by the Purchaser. For this purpose, specific approval shall be obtained by the Contractor after indicating their requirements. However, the Contractor has to abide by the rules & regulations set by the Purchaser from time to time. The area for fabrication yard shall be made available to contractor by Client against chargeable use of its land area. Contractor shall have to arrange for water, electricity, etc. for use on its own.

1.6 The work shall be carried out according as per the steel structural fabrication drawings to be developed by the Contractor based on design drawings & scheme drawings approved by the Purchaser/Consultant. For all structures, necessary layout and details are to be developed by



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the Contractor keeping in view the statutory & functional requirements of the port and facilities and providing enough space and access for operation, use and maintenance. Certain minimum requirements are indicated in this specification for guidance purpose only. However, the Contractor's offer shall cover the complete requirements as per the best prevailing practices and to the complete satisfaction of the Purchaser.

1.7 Contractor shall inspect the site, examine and obtain all information required and satisfy himself regarding matters and things such as access to site, communications, transport, right of way, the type and number of equipment and facilities required for the work, availability of local labour, materials and their rates, local working conditions, weather, tidal / flood levels, subsoil conditions, natural drainage, etc. Ignorance of the site conditions shall not be accepted by the Purchaser as basis for any claim for compensation or extension of time. The submission of a bid by the Contractor will be construed as evidence that such an examination was made and any later claims / disputes in regard to price quoted shall not be entertained or considered by the Purchaser on account of ignorance of prevailing site conditions.

1.8 Contractor shall comply with all the applicable statutory rules pertaining to Factory act, Fire safety rule of Loss prevention association, Water act for Pollution control, Explosives act etc. Provisions of Safety, health and welfare according to Factories act shall also be complied with. Statutory clearances and norms of State Pollution Control Board shall be followed. Statutory body /Act requirements shall be fulfilled by the Contractor and in case any modifications /additions to the building /Structures are to be made as per the above, shall be carried out by the Contractor at no extra cost to the Purchaser.

SECTION-2: SCOPE OF WORK

2.1 The scope of work shall cover, but shall not be exclusively limited to, the following:



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This scope of work is to cover preparation of scheme drawings for rectification, modification & strengthening of existing structures, dismantling & removal of steel structures, preparation of design calculations, detail engineering including design drawings, fabrication drawings and getting approval from consultant of design calculations, drawings & schemes for modification, rectification or dismantling, scheme for temporary support for existing pipe line or other loads supported on existing structure, erection procedure, including procurement of raw steel, fabrication & supply, erection, painting of existing structures, painting of rectified & refurbished structures, painting of new structures, procurement and supply of sheeting, finishing and handing over of all steel structural work on a turnkey basis for the Project / Works including all incidental items not shown or specified but reasonably implied or necessary for the completion and proper functioning of the plant, all in strict accordance with the specifications, including revisions and amendments thereto as may be required during the execution of the work.

Miscellaneous Steel Structures

There may be miscellaneous Steel structures like platform, crossovers, staircase, cat ladder, etc., which shall be decided during detail engineering. The Structures shall be fabricated & erected as per approved design & fabrication drawings.

This specification shall apply to general structural steel works as columns, beams, bracings, portals, platforms, ladders, staircases, chequered plate, grating for walkway, or other structures required for completion of works and proper functioning up to the satisfaction of Consultant / Client.

2.2. Collection of all site related data & conducting site investigations

2.3. Design, preparation of all design drawings, scheme drawings, fabrication drawings, etc.

2.4. Obtaining Purchaser's/Consultant's approval on Structural steel design drawings, scheme drawings prepared by the contractor for ease of fabrication & erection.

2.5. Supply of all materials viz, raw steel, fixtures, fasteners, bolts, nuts, washers, Paints, etc as per the requirements. Raw steel plates & sections, paints, electrodes, gratings and other bought out items shall be procured by the contractor from approved / preferred makes only.

2.6. Supply of consumables like electrodes for welding, gases for gas cutting etc. including supply of temporary supports for rectification & dismantling works, plant & machinery, tools, tackles, instruments for fabrication and erection.

2.7. Supply of temporary supports for rectification & dismantling works. The weight of such temporary supports, temporary bracings, fasteners or other items used for the purpose will not be taken into account for the purpose of payment.

2.8. Providing facilities for transport and handling

2.9. Making arrangements for all services like approach to site, electricity, water etc

2.10. Fabrication of structures, their transport and proper storing at site.

2.11. Providing facilities for testing of materials and conducting NDT.



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- 2.12. Providing all reasonable facilities for inspection by Purchaser/Consultant
- 2.13. Conducting NDT as stipulated by the Purchaser and making test results available to Purchaser / Consultant for evaluation.
- 2.14. Erection of structures.
- 2.15. Application of paints at shop after fabrication and at site after erection.
- 2.16. Compliance with preliminary acceptance tests / inspection, liquidation of defects; compliance with final acceptance tests / inspection, liquidation of defects.
- 2.17. Deploying exclusive survey team for structural works and requisite skilled and unskilled manpower.
- 2.18. Implementing field-engineering decisions as directed by the Purchaser.
- 2.19. Any other work deemed incidental for the completion of the overall work but not included in the above detailed scope.
- 2.20. Preparation of strengthening / modification schemes of existing structures. Such schemes shall be submitted along with complete details and design calculations with back up data for assumptions, if any.
- 2.21. Dismantling, retrieval, sorting and storing of specified existing structures as directed by the Purchaser at specified location within port. For credit item i.e. taking away of scrap material will be measured on actual weighment basis. The weighment shall be made in presence of representative of Port Trust and C.I.S.F. personnel at Main store, Deendayal Port Trust, new Kandla, for the same the contractor shall obtain the necessary permission for concern authority and if any charges are chargeable that shall be paid by Contractor. No extra payment will be made. Further, the contractor shall have to deposit 100% (full) amount offered for credit item and shall have to pay necessary tax at prevailing rates chargeable before taking away the materials from site.)
- 2.22. Preparation of "As Built" drawings for all the structures and hand over to the Purchaser (along with a scanned soft copy) the completed structural work.
- 2.23. Supply of all loading data for RCC foundation, layout drawing, HD bolt insert details and all other necessary information required for Foundation/ RCC work. Where future expansion is envisaged, the contractor shall furnish load data separately for present and future construction.
- 2.24. The Contractor shall prepare a programme showing the schedule of preparation and submission of design drawings, scheme drawings (for modification & strengthening of existing structures), fabrication drawings procurement of raw steel, supply of fabricated steel structures, inspection, erection alignment, painting for each area / unit. The erection dates shall be the dates for completion of all the follow-up work in addition to main erection keeping overall completion of project in view. The programme shall include quantum of different activities of work planned month wise to complete the work.



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2.25. Any other work deemed incidental for the completion of the overall work but not included in the above detailed scope.

2.26. The descriptions of steel structural works are indicative only and not limited to as mentioned. If any other units are deemed necessary for completion of the Project those are to be supplied by the Contractor.

2.27. Successful Contractor shall also ensure the adequacy of the structure parameters to suite equipment layout and technological requirement.

2.28. The Contractor shall indicate approximate volume of work for new steel quantity, dismantling steel quantity and strengthening steel quantity which shall remain binding unless the scope of work indicated in TS changes.

2.29. FOR DISMANTLING OF EXISTING STEEL STRUCTURES AND TAKE AWAY AFTER FULL PAYMENT TO CLIENT. The work shall cover:

- a. Preparation of dismantling scheme.
- b. Provision of temporary supports to support existing structure and pipeline or other loads resting on the structure.
- c. Strengthening of existing structures as may be necessary before or during dismantling, and restoration of damaged portion, if any, without affecting the safety of structures and equipment.
- d. Dismantling and cutting of steel structural components shall be done by manual cutting only.
- e. Retrieval, sorting and take away of dismantled structures as per the instructions of Consultant / Client.
- f. For credit item i.e. taking away of scrap material will be measured on actual weightment basis. The weightment shall be made in presence of representative of Port Trust and C.I.S.F. personnel at Main store, Deendayal Port Trust, new Kandla, for the same the contractor shall obtain the necessary permission for concern authority and if any charges are chargeable that shall be paid by Contractor. No extra payment will be made.
- g. The contractor shall have to deposit 100% (full) amount offered for credit item and shall have to pay necessary tax at prevailing rates chargeable before taking away the materials from site.)

SECTION - 3: RECTIFICATION & STRENGTHENING OF EXISTING STRUCTURES

3.1 General & Scope



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The Rectification & strengthening of part or portion of existing structures such as portals, beams, bracing angles, plates, etc. as identified by Consultant / Client for carrying out rectification & strengthening works, on basis of scheme drawings & design calculation prepared and submitted by contractor and approved from Client / consultant.

The works shall including removal of existing part of structure required for rectification & strengthening by manual cutting only at all height and level including supply, fabrication, erection of necessary new structure, plates, beams, etc at appropriate locations, fixing by permanent G.I bolting (8.8 Grade) with provision of bolting to existing structure, if required shall be made, painting of rectified structure as per painting specification in the TS, including alignment of structures true to line, level, plumb and dimension all works shall be completed as per Specification, scope and description of works, drawings and as per direction of the Consultant / Client.

3.2 Rectification of structures

The items identified and authorized for rectification & strengthening shall be rectified as per approved scheme drawings.

3.3 Painting of Refurbished Part

After rectification & modification of structures, entire structure shall be painted as per painting specification in the TS.

SECTION -4: DISMANTLING OF STEEL STRUCTURES

4.1 General



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The structures such as fire monitor structure, portals, pipe bridge, trestles, beams, bracing angles, plates, grating, hand railing, etc. required for dismantling shall be identified and listed out by Contractor which have corroded beyond repair and are not contributing to the structure, and authorized by Consultant / Client for carrying out dismantling works.

4.2 Scope of work

The work shall cover:

- a. Preparation of dismantling scheme.
- b. Provision of temporary supports to existing pipelines, cables, equipment, walkway or others.
- c. Strengthening of existing structures as may be necessary before or during dismantling, and restoration of damaged portion, if any, without affecting the safety of structures and pipelines etc.
- d. Dismantling of steel structural components.
- e. Dismantling and cutting of steel structural components shall be done by manual cutting only.
- f. Retrieval, sorting and and take away of dismantled structures as per the instructions of Consultant / Client.
- h. For credit item i.e. taking away of scrap material will be measured on actual weighment basis. The weighment shall be made in presence of representative of Port Trust and C.I.S.F. personnel at Main store, Deendayal Port Trust, new Kandla, for the same the contractor shall obtain the necessary permission for concern authority and if any charges are chargeable that shall be paid by Contractor. No extra payment will be made.
- i. The contractor shall have to deposit 100% (full) amount offered for credit item and shall have to pay necessary tax at prevailing rates chargeable before taking away the materials from site.)

SECTION -5: DESIGN OF STEEL STRUCTURES

This specification shall apply to general structural steel work.



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5.1 Design of Structures

- a) The Steel Structures shall generally be designed as per IS: 800-2007 (Limit State Design method) and as per provision mentioned in this tender document.
- b) Stress enhancement as per any codal provision is not allowed in the design of any member. Further maximum stress ratio shall not exceed 0.80 for any member
- c) For Analysis of steel structural frame work STAAD PRO software shall be used, for design of members EXCEL files shall be used. Soft copy of the executable STAAD file shall be submitted to Consultant along with the hard copy of the drawing for its approval. Backup calculations for input loads as well as design of individual elements carried out separately, shall also be submitted. The design sheets (e.g. editable EXCEL files indicating active formulas) shall be submitted for all members. No separate design criteria shall be proposed except for any clarifications / discrepancies.
- d) Structures shall be designed such that they are economical and safe and meet the functional and service requirement of the technological process for which they are designed.
- e) The structures shall be designed conforming to the relevant safety regulations, Factory Acts, Electricity Rules and stipulations of statutory bodies as applicable to the project.

5.2 Description of Design loads

Loads considered in design shall allow fully for all aspects of:

- a) Dead weight of structures, pipe lines, equipment, walkway, cabling and any item of a permanent nature.
- b) Live load for pipe lines (product Load) and walkway.
- c) Temperature loads w.r.t. maximum range of temperature variation for climatic conditions $\pm 25^{\circ}\text{C}$.
- d) Dynamic loads from screens and other such reciprocating/ vibrating machinery or equipment.
- e) Wind Loads
- f) Seismic loads
- g) Fire water sprinkler system, if applicable.

5.3 Design Loads To be considered

Besides technological loads, all platforms, walkways, stairs etc. shall be designed for the following live loads:

- | | | | |
|---------------------------|---|---|-------------------|
| a) All Working Floors | : | 5 | KN/m ² |
| b) Walkways and Platforms | : | 3 | KN/m ² |
| c) Visitor's galleries | : | 4 | KN/m ² |



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d) Maintenance platforms : 4 KN/m²

Including crane level walkway.

e) Staircase and treads : 4 KN/m²

f) Monorail walkways : 4 KN/m²

g) Handrails (Horizontal) : 0.75 KN/m run

h) Ladder : 0.9 KN at middle of rung

i) For pipe loads, the same shall be as per piping details layout.

j) For design of monorails, hoists etc, an impact factor of 1.25 for electrically operated cranes and 1.1 for hand operated cranes, shall be considered. Weight of pulley block and other accessories shall be considered.

5.4 For all other loads, not specified above, the following codes shall be followed.

a) All live loads shall be considered in accordance with IS: 875(Part-2) -1987.

b) Wind loads shall be in accordance with IS: 875(Part-3) -1987 and any other consideration specific to the site. For wind load calculation the following data may be considered

- Basic wind speed (V_b) = 50 m/s
- Risk co- efficient (K_1) = 1.0
- Terrain ht and Structure size factor (K_2) shall be calculated with Category 1.
- Topography co- efficient (K_3) = 1.0

c) Seismic loads shall be in accordance with IS: 1893-2005 part IV

d) In absence of any suitable provision for design loads, any other recognized code of practice may be followed subject to prior approval of the Consultant / Client.

e) Equipment loads shall be considered over and above the imposed loads. Equipment loads (apart from dead weight) shall be considered as given by equipment supplier.

5.5 Combination of loads

Based on Primary Load Cases, Load Combinations as per Table-4 of IS:8002007 for Limit State of Strength & for Limit State of Serviceability and clause 8.0 of IS: 875(Part 5) 1987, as applicable, shall be formed and applied to staad analysis to give the most severe loading condition for design strength and serviceability including stability against overturning (0.9DL + WL/EL combination) of structures.

5.6 Limiting deflection

The vertical deflection & horizontal deflection shall be limited in various elements of structures and shall be limited to Span/325 for all cases.



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5.7 Miscellaneous design requirements

a) The minimum thickness of structural steel elements shall not be less than 6 mm. Minimum section shall not be less than those as, if mentioned, in proposed cross section as per structural tender drawings, or in other case shall not be less than NPB 300X150x36.52, ISMB 250 for columns & pipe support & primary beams, ISA 50X50X6 for bracings/lacings, ISMC 125 for secondary floor beams respectively. All plates of a particular thickness shall be of same grade.

b) All connections shall be bolted joints, unless noted otherwise, and the diameter of fasteners shall not be less than 16 mm with at least two bolts per joint.

c) The diameter of anchor bolts / anchor fasteners shall not be less than 16mm, with a minimum of 4 bolts per base plate connection.

d) All butt welds shall be full penetration butt welds.

e) The size of fillet welds shall not be less than 6 mm.

f) In case of built-up members structural elements shall be welded continuously on both side of I section.

g) Field connection and splices shall be only bolted type and made as follows:

By High strength bolts, nut and washers shall comply with IS:3757; IS6649;IS:6623 & IS:1367 and ASTM A 325. mild steel bolts shall comply with IS:6639 .High strength bolts shall be threaded in accordance with IS:4218. All nut, bolts and washers shall be hot dip spun galvanised suitable for use in an exposed external environment and shall conform to IS:4759.

i) By permanent bolts (for secondary members such as purlins, wall runners etc.)

ii) By High Strength Friction Grip bolts (HSFG).

iii) The thickness of gusset plate and welded end plates shall not be less than respective component of the member to be connected and shall have a minimum thickness of 6 mm.

iv) Column splices shall be developed for the full strength of the column. Abutting surfaces of both the upper and lower lift of the column shall be milled.

h) Access to all floors, walkways and landings shall be by staircases. Access to platforms and landing of secondary importance or where such access is used only rarely, shall be by vertical ladders with safety hoops.

i) Edges of floors, walkways, stairs and landings shall be provided with safety hand railings. All hand railings shall be of tubular hand railings with vertical post, top rail and mid rail made up with tubes.

j) Floors, walkways and landings shall be covered galvanized gratings, resting on steel structural framework, to suit the technological requirements. Floor bracings shall be provided in all working floors to take care of the horizontal loads, due to equipment / due to seismic consideration / owing to nominal skew forces.



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k) Design drawings submitted by the vendor shall carry the signatures of the designer and the approval authority of the vendor. Each drawing shall have a unique drawing number & a unique description. Drawing shall have enough free space for Consultant / Client's comments and stamp of approval.

l) Vendor shall submit readable structural design drawings (including Bill of Material) to purchaser / consultant for approval, along with the approved technological drawings. All other supporting documents like the detailed load calculation, design sheets shall be submitted for approval along with design drawings.

m) Even if the drawings are approved / Commented by the Purchaser / Consultant, the Contractor shall not be relieved of the responsibilities for the accuracy of the detailed dimensions shown in the drawings and the safety of all structural connections.

n) After approval of the design drawings a scanned soft copy bearing the stamp of approval shall be submitted to the Purchaser / Consultant for reference.

o) The slopes of bracings, lacings for columns, diagonal members of trusses, bridges, girders etc shall be kept preferably in the range of 35 to 50 degrees.

p) Structural steel sections & plates shall be so selected that they are readily available in the market. A list of such sections & plates shall be submitted for Purchaser's approval before commencing design works.

q) All 2-legged trestles shall be completely braced in vertical plane. All 4legged trestles shall be completely braced in all four vertical planes. In addition, specified horizontal planes shall be completely braced to provide stiffness against torsional sway.

r) Structural schematic general arrangement with plans at various levels, elevations along each row and axes, sections, considered loads and load diagrams with location etc. and Structural design drawings with BOQ and Table of members containing design forces along with design calculations shall be submitted for Purchaser's/Consultant's approval. However the approval shall be limited to checking of overall dimensions, general stability of system, effective load transfer and deflection limits etc. The approval shall not relieve the contractor of his responsibility of correctness in design, adequacy of connections, accuracy etc.

s) Submission of Stability certificate for all the steel structures is under the scope of the contractor.

5.8 Access staircase, walkways, platforms and ladders

a) All other walkways and stairs leading to areas for maintenance purpose, shall have a minimum width of 800 mm of walkway/flight of stair, unless required otherwise.

b) Staircases shall be generally designed with slope of approximate 37.5° with the horizontal (in no case the slope shall exceed 40° with the horizontal). All flights of a particular stairwell shall have same slope.

Intermediate landings shall be provided wherever required such that vertical rise of each flight does not exceed 3000 mm. Risers in one flight shall be equally spaced.



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- c) Walkway floors and stair treads shall be designed with galvanized grating.
- d) Rise of treads in staircases shall not exceed 200 mm. Width of treads shall not be less than 250 mm.
- e) Minimum headroom of 2200 mm shall be provided over operating platforms, visitor's galleries, or other areas with possibility of public gathering. In all other platforms, walkways and stairs, minimum headroom of 2000 mm shall be provided.
- f) Cat ladders shall be provided for access, wherever provision of staircase is impractical due to limitations of space, or the access is required very infrequently.
- g) Wherever the height of cat ladder exceeds 4.0 m, safety cage shall be provided. Intermediate landing shall be provided to cat ladders such that vertical height of single rise does not exceed 8.0 m.
- h) Cat ladders shall be designed with following provisions:
- | | | |
|---|---|--------|
| i) Width of rung | = | 500 mm |
| ii) Minimum rise of rung | = | 250 mm |
| Maximum rise of rung | = | 300 mm |
| iii) Minimum clearance from rung of ladder to back of cage (in case of caged ladders) | = | 700 mm |
| iv) Minimum clearance from the centre of cage all round | = | 350 mm |
| v) Slope of cat-ladders: | | |
| I. For normal cat-ladders, slope shall be | within the range of 75°-90° with the horizontal. | |
| II. For ship-type ladders (i.e. cat-ladders with short side handrails) | the slope shall be within the range of 65°-75° with the horizontal. | |
| vi) Cage shall start from 2500 mm above ground level. | | |
| i) All walkways, platforms and stairs shall be provided with safety handrails. All handrails shall be constructed with steel tubes. The vertical posts shall be located at maximum 1000 mm intervals. The vertical post shall be of 40 NB(M), top rail and mid rail shall be of 32 NB(M) tubes. The toe guard shall be made of skelp. In case of stairs, the toe guards need not be provided. | | |
| j) The vertical height of hand-railings on walkways and stairs shall be minimum 1000 mm above floor level. | | |

5.9 ADDITIONAL REQUIREMENTS FOR PIPELINE SUPPORTING STRUCTURE

Design considerations

- a) Bridges shall be provided to support pipelines for which maximum permissible span are less than the distance between supporting trestles.



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- b) Trestles which are designed to transmit longitudinal loads (along the length of pipeline) to the foundation shall be four legged construction. Other trestles which transmit only the vertical load to the foundation may be two legged construction.
- c) Access stair cases and walkway platforms shall be provided for maintenance of equipment, pipelines, structures, valves etc.). Maintenance walkways with hand-railing shall also be provided along the pipeline.
- d) There shall be a four legged / fixed trestle on either side of turning point in the pipe line stockade.
- e) Longitudinal forces equal to product of coefficient of friction with the load coming on each support of pipe shall be considered for design of pipe rack supporting structure.

SECTION -6: FABRICATION OF STEEL STRUCTURES

6.0 SCOPE OF WORK

The scope of work under fabrication includes, but not limited to, the following:

- a) Preparation and supply of material indents, bolt lists bought out items list.
- b) Procurement and collection of all steel materials from stockyards/stores, including loading, transportation, unloading and stacking and storing on skids or supports.



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- c) Procurement and supply of all consumables like bolts nuts, washers, electrodes, paints, shims, packs, etc., including allowance for spares and wastage.
- d) Preparation and submission of fabrication drawings, modification /rectification sketches, erection drawings, sheeting drawings, as made drawings, bill of materials, bolts lists and shipping documents for approval/information of purchaser.
- e) Preparation of design calculations for non-standard connections, temporary bracings etc. for approval of purchaser.
- f) Cold straightening of section and plates, whenever they are bent and kinked.
- g) Fabrication of all steel structural components covered under tender drawings, design drawings and generally described under the scope of the project.
- h) The Contractor has to make arrangements and bear the cost of conducting tests, such as chemical analysis, physical and mechanical tests on raw materials in case of inability to produce material certificate for the material procured by him.
- i) Making arrangements and bearing cost for providing all facilities for conducting ultrasonic, X-ray or gamma ray tests of welds; getting the tests conducted by reputed testing laboratories (Pre-approved by the Consultant / Client) making available test films / graphs, reports and interpretation.
- j) Control Assembly of fabricated structural components at shop, wherever required.
- k) Preparation of steel structural surfaces for painting as provided in the specifications / drawings.
- l) Application of one primer coat of painting at shop, as specified in the design drawing/ specifications.
- m) Loading, transportation from fabrication workshop to site of erection and unloading of all steel structural components / units / assemblies.
- n) Preparation of "As-built" drawings.

6.1 PREPARATION OF FABRICATION DRAWINGS

6.1.1 Based on the design drawings the contractor shall prepare fabrication drawings, erection drawings, Bill of materials, drawing office dispatch lists/ shipping documents, schedule e of bolts & nuts and as built drawings. All the drawing work shall be done in metric system and all writing work shall be in English.

6.1.2 The fabrication drawings shall show full length layout with all connecting members and connections marked thereon. The fabrication drawings shall include all the necessary blown up details required for correct fabrication of the structures to meet design requirements. These drawings shall be made in conformity with the best modern practices and with due regard to speed and economy in fabrication and erection. Each erection piece shall be clearly identified by an erection mark in these drawings.



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6.1.3 Drawing shall be prepared in metric system in accordance with provisions of IS:962, IS: 10711-2001; IS: 11665-1985; IS 10713-1983 and IS:7973-1976. The fabrication drawings shall specify the following details.

a) Type, size and length of welds in case of welded connections,(specifying clearly shop or site weld). Length of weld specified shall be effective length (excluding end crates).

b) In case of bolted joints, arrangement of bolts and specification of bolts, nuts etc.(specifying clearly shop and site bolts).

c) Specification of electrode/wire flux.

d) If required special provision to be mentioned in the drawings for handling of structures during and after fabrication.

e) Specification of paint and corresponding surface preparation for painting.

f) General arrangement/markings plan.

g) Reference to design drawings.

h) Material list indicating mark number wise material requirement giving size, weight, material specification, identification number of each items, number of pieces required etc.

i) Each drawing shall contain section wise raw steel requirement and size & grade wise requirement of bolts, nuts, washers etc specific to that particular drawing along with BOQ.

j) Sheet drawings shall be prepared showing location of various types of sheets (including translucent sheets), sizes of sheets, fixing arrangement, openings etc. Approximate sheeting area for each type of sheeting shall be indicated in the drawings. Specification of preparation of mating surfaces in case of connection by High strength bolts.

k) Appropriate edge preparation in case of butt/groove welds in accordance with IS: 9595-1996, for all plates and sections having thickness greater than 8 mm.

l) Erection clearances in order to facilitate smooth erection at site shall be as per IS: 800. The erection clearances for cleat connected ends of members connecting steel to steel shall preferably not greater than 10mm at each end. The erection clearance at ends of beams shall not be more than 20mm. at each end. But where for particular reasons greater clearance is necessary, suitably designed seats shall be provided.

m) Each erection piece shall be clearly identified by an erection mark in these drawings. All loose members shall be given part mark, which shall be 'wired on' the main erection piece for despatch.

6.1.4 Fabrication drawings shall be prepared in such a manner that Structures can be despatched from fabrication shop to erection site with maximum economic transportable size, so as to reduce work involved at site to a minimum.

6.1.5 Minimum size of fillet weld based on thickness of thicker element connected shall be



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- (a) 6 mm for plate up to 20mm thick
- (b) 8 mm for 21 to 30 mm thick
- (c) 10 mm for 31 to 50 mm thick
- (d) 12 mm for 51mm & above

All members shall be welded to the gusset for full contact length available.

Minimum fillet weld thickness for site welds shall be 8 mm with plates of thickness more than 8 mm.

6.1.6 All bracing members shall be connected for 50% of capacity in tension or force indicated whichever is greater, subjected to a minimum of 5 tonnes.

6.1.7 Spacer plates for double and starred angle members shall be provided at a spacing of not more than 40 r (min) for compression elements and 80 r(min) for tension elements, where r (min) is rxx and ryy of the single angle respectively.

6.1.8 All gussets shall be of minimum 8mm thick. In the drawings thickness of gusset plate corresponding to forces in members shall be (a) 8 mm gusset plate for forces up to 15 tonnes. (b) 10 mm gusset plate for forces 15 – 25 tonnes. (c) 12 mm gusset plate for forces 25 – 40 tonnes. (d) 14mm gusset plate for forces 40-60 tonnes. (e) 16 mm gusset plate for forces 60 - 80 tonnes. (f) 18 mm gusset plate for forces 80 -100 tonnes. (g) 20 mm gusset plate for forces 100 ton and above.

6.1.9 3 plates built up members like columns; beam etc. shall be formed by continuous automatic welding. In 3 plate built-up beams and columns, 500 mm length on either side of site joint between flange and web shall be site welded. Erection welding of joints for column and beams shall be carried out in following order (a) Weld the web over entire length. (b) Weld the flanges. (c) Weld the joint between flange and web.

6.1.10 All bolted connections shall have a minimum of 2 bolts with c/c distance limited to minimum spacing as per IS: 800.

6.1.11 Simple beam connections with Cleat-plate, unless otherwise stated in the drawings, shall be designed and detailed for 60% of beam shear carrying capacity for rolled sections (80% of section strength for built-up section or rolled section with cover plates) or force indicated whichever is greater, subjected to a minimum of 5 tonnes.

6.1.12 Moment connection between beam & column shall be designed for 100% of moment capacity of the beam section.

6.1.13 Wherever there is risk of nuts becoming loose due to vibration, lock nuts shall be provided, or nuts shall be welded after alignment and tightening. 6.1.14 For all connections by permanent bolts, two no. of washers shall be used. One washer bearing against the head and the other bearing against the nut.



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6.1.15 Detailing of structural steel members subject to dynamic loading shall be such as to ensure smooth transition of load, as well as best behaviour under stress due to fatigue. Welding across tension flange of crane girders is not permitted.

6.1.16 Ends of built up box sections and pipes shall be sealed with plates welded at the ends.

6.1.17 For detailing connection, the allowable stress for materials, welds, bolts etc, shall be as per IS: 800 and IS:816-1969, or as specified in the drawing.

6.1.18 The contractor shall be responsible for detailing and adequacy of all connections. The detailed connections shall provide adequate strength for transfer of force in the structural elements, as indicated on design drawings. Detailing shall be such that erection shall be convenient and free from all interfaces, drilling and cutting at site.

6.1.19 All the fabrication drawings, sheeting drawings, As-built drawings shall be prepared in Auto-CAD format and shall be submitted both in hardcopy and soft copy.

6.1.20 The contractor shall ensure correctness & completeness of fabrication drawings. The contractor shall declare on each and every fabrication drawing that the drawing has been checked for dimensional correctness, matching and proper interfacing of elements, member properties, fulfilment of structural requirements viz. welding/bolting etc. and the material weights shown in the BOQ.

6.1.21 The fabrication drawings and documents shall be submitted to the purchaser for reference/ review. Even if the drawings are Approved / Commented by the Purchaser / Consultant, the Contractor shall not be relieved of the responsibilities for the accuracy of the detailed dimensions shown in the drawings and the safety and adequacy of all structural connections as per forces indicated in the design drawings.

6.1.22 Scanned soft copy of drawings bearing approval/ reference/ information stamp of Employer, shall be submitted after final clearance of drawings for each unit.

6.1.23 On all drawings, dimensions shown in figures shall be acted on. Erection drawings in requisite number of sets shall be submitted to the Purchaser / Consultant showing thereon all authorized additions and alterations in the process of erection. These drawings shall show the "As-Built Installations". Scanned soft copy of such drawings shall be submitted for reference.

6.1.24 Supply and distribution of fabrication drawings and other documents like bolt list etc for the contractor's own use or for the use of his subcontractors shall be the responsibility of the Contractor.

6.2 MATERIALS

Structural steel and other related materials for construction shall conform to ANNEXURE-E.

6.2.1 Due to non-availability of specified materials, suitable substitutions may be provided with the consent of the purchaser. Such substitution shall be incorporated in the "As-built" drawings.

6.2.2 All the items are to be cut as per requirements of the drawing. If joints are to be provided



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in any item, in order to meet requirements of size and shape, cutting plan showing locations of joints shall be prepared for consideration of purchaser. Joints provided shall be incorporated in "As-built" drawings.

6.2.3 Rolling and cutting tolerances shall be as per IS: 1852 -1985.

6.2.4 If test certificate for the material is not available from the main producer, the tests for Chemical Composition, Mechanical Properties, Weldability shall be carried out at the cost of the Contractor.

6.2.5 Before taking up fabrication of heavy sections (built-up sections made of thick plates and heavy rolled sections), the contractor should test the material with respect of cracks, undulations, laminations, cleavages etc. and reject it if faulty. If such fault is detected afterwards, the Contractor has to replace the structure at his own cost. 6.2.6 Where steel castings are to be used the same shall conform to IS: 1030:1998

6.2.7 Only tested materials shall be used. Manufacturer's test certificate, including chemical analysis shall be supplied.

6.3 STORING OF MATERIALS

6.3.1 Materials shall be stored and stacked properly ensuring that place is properly drained and is free from dirt. It shall be ensured that no damage is caused due to improper stacking.

6.4 MATERIAL PREPARATION

6.4.1 Cut edges shall be finished smooth by grinding or machining wherever necessary. Sufficient allowance (3 mm to 5 mm) should be kept in the items in case machining is necessary.

6.4.2 Cutting may be effected by gas cutting, shearing, cropping or sawing. In gas cutting of high tensile steel, special care is to be taken to leave sufficient metal to be removed by machining so that all metal that has been hardened by flame is removed.

6.4.3 Sufficient shrinkage allowance (@ 1mm/M) shall be kept wherever heavy welding is involved.

6.4.4 Straightening and bending shall be done in cold condition as far as practicable.

6.4.5 If required, straightening and bending may be done by application of heat between 900° C and 1100° C. cooling down of the heated item shall be done slowly.

6.5 DRILLING AND PUNCHING OF HOLES

6.5.1 Drilling and punching of holes for bolts shall be done as per IS:800 unless otherwise specified by the purchaser.

6.5.2 Drifting of holes for bolts during assembly shall not cause enlargement of holes beyond permissible limit or damage the metal.



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6.5.3 Holes for bolted connection should match well to permit easy entry of bolts. Gross mismatch of holes shall be avoided.

6.5.4 Permissible deviation in holes for mild steel bolts of normal accuracy and high strength bolts are given in the Annexure-A.

6.6 FABRICATION

6.6.1 Fabrication of all structural steelwork shall be in accordance with IS: 800 in conformity with various clauses of this specification, unless otherwise specified in the drawings.

6.6.2 Fabrication of structures shall preferably be taken up as per the sequence of erection.

6.6.3 All erection units shall bear erection mark no. and reference drawing no. at a prominent location on the structures for easy identification at site.

6.6.4 Fabricated structures shall conform to tolerance as specified in this standard and in IS: 7215-1974. In case of contradiction, tolerances specified in this standard shall prevail.

6.6.5 All the components of structures shall be free from twist, bend, damage etc.

6.6.6 Assembly of structures shall be carried out by using suitable jigs and fixtures in order to obviate distortion during welding.

6.6.7 Cutting of items specially for truss, bracing, bunker, hopper, galleries surge girder, portal etc, shall be done only after checking of sizes as per Layout.

6.6.8 Surface, wherever machining is specified, shall be either planed or milled or ground to ensure maximum contact.

6.6.9 If end-milling or machining is planned after the assembly is over, sufficient allowance (5 mm to 15 mm) shall be kept in the items where milling/machining is to be done.

6.6.10 If pre-bending of the plate is required to avoid welding distortion, it shall be done in cold condition.

6.6.11 If extra joints are required to be provided in column, beams, girder etc, approval should be obtained from the purchaser. However, as general guidance following it is suggested that splice joints of column, beams, girder shall be of full strength butt weld and shall not be provided at the centre or mid span of member, wherever possible those shall be located at L/4 away in both directions from centre or mid span of member and in zones of minimum or substantially lesser stress.

6.6.12 All shop splices shall be made by means of full strength full penetration butt welds unless otherwise specified.

6.6.13 Back strip shall be provided in case of butt joints where welded with sealing run is not possible on account of inaccessibility. Ends of butt welds are to be continued beyond the limit of joints on run on and runoff plates.



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6.6.14 Splice joints of flange and web should preferably be staggered.

6.6.15 Prior approval shall be obtained for any deviation from splice locations shown in drawings and/or for any fresh splice locations required in view of limiting length of structural members available. However beams shall not have field joints within middle third of span. Also no splice part shall be of less than one metre length.

6.6.16 Prior approval shall also be obtained for any change of section with respect to those shown in drawings. In case of change of sections the corresponding changes in the connecting members shall be carried out.

6.6.17 Central lines shall be punched on at least two faces of columns near the base and column cap.

6.6.18 All loose items / parts shall be suitably tack welded with main part.

6.6.19 Sufficient trial assembly of fabricated components (dispatch elements) shall be carried out in the fabrication works to control the accuracy of workmanship.

6.6.20 Where necessary, washers shall be tapered or otherwise suitably shaped to give the heads of nuts and bolts satisfactory bearing.

6.6.21 The threaded portion of each bolt shall project through the nut at least by three threads.

6.6.22 Tolerance of assembled components of structures is given in Annexure-B.

6.6.23 Permissible deviations from designed (true) geometrical form of the dispatch elements shall be in accordance with IS: 7215-1974.

6.7 WELDING

6.7.1 All welding work should be carried out as mentioned under the "Welding of Structures" section of this specification.

6.8 PAINTING

All painting work should be carried out as mentioned under the Section named, " Surface preparation and painting of steel structures". One coat of primer shall be applied on all fabricated structures before dispatch for erection.

6.9 STEEL GRATINGS

6.9.1 General Requirements

6.9.2 This covers the provision of Galvanized gratings and ms grating in mezzanine flooring and other structures of warehouse/building

6.9.3 Material

6.9.4 Steel used in gratings shall conform to grade 'A' of IS:2062.

6.9.5 Fabrication Drawings



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6.9.6 Fabrication drawings shall be prepared based on design drawing. The contractor shall submit the fabrication drawings for different spans. Thickness of all gratings shall be kept as uniform unless otherwise specified.

6.9.7 Fabrication

6.9.8 All gratings shall be fabricated in factory.

6.9.9 All gratings shall be rectangular in pattern. The size and spacing of bearing bars and cross bars shall be as per design drawings.

6.9.10 The grating shall be accurately fabricated and finished, free from wraps, twists or any other defects that would impair their strength, serviceability and appearance.

6.9.11 Erection, Alignment and Installation

6.9.12 Grating work shall include making cut-outs and clear openings for all columns, pipes, ducts, conduits or any other installation penetrating through the grating work. Such cut-outs and clearances shall be treated as specified in subsequent clauses.

6.9.13 The grating shall be notched, trimmed and neatly finished around flanges and webs of the columns, moment connections, cap plates and such other components of steel structural encountered during the placement of grating. In all such cases, the trimming shall be done to follow the profile of the components encountered. After trimming, the binding strip shall be provided on the grating to suit the profile so obtained.

6.9.14 Openings in gratings for pipes or ducts that are 150mm (in size or diameter or larger) shall be provided with steel bar toe plates of not less than 5mm thickness and appropriate width, set flush with the bottom of the bearing bars.

6.9.15 Openings in gratings that are more than 5mm but less than 5mm in size or diameter shall be welded with plates of size shown in the detailed drawing set flush with the bottom of grating panel.

6.9.16 Unless otherwise indicated in the drawing, grating units in all penetrations shall be made in split sections, accurately fitted and neatly finished to provide proper assembly and erection at the job site.

6.9.17 Gratings shall be installed in position by welding on the steel beams.

6.9.18 Galvanization

6.9.19 Wherever specified gratings shall be provided with galvanization. The weight of the zinc coating shall not be less than 610 GSM unless otherwise noted as per IS 4759.

6.9.20 Purity of zinc to be used for galvanizing shall be 99.5% as per IS.

6.9.21 After the shop work is complete; the structural members shall be punched mark with erection mark and be hot dip galvanized. Before galvanizing the steel grating shall be thoroughly blast cleaned to near white metal surface (SA2 ½) or chemically cleaned in acid bath.



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6.9.22 G.I Grating and MS Grating shall be fabricated as per PMC/Design-In-Charge drawing

6.10 INSPECTION & TESTING

6.10.1 The purchaser/Inspector shall have free access at all times to those parts of Contractor's or his Sub- Contractor's works which are concerned with the fabrication of steel works. Also he shall be afforded all reasonable facilities at all stages of preparation, fabrication and trial assemblies for satisfying himself that the fabrication is being undertaken in accordance with the provisions of relevant specification.

6.10.2 All gauges and templates, tools, apparatus, labour and assistance for checking shall be supplied by the contractor free of charge. The contractor shall have a digital elecometer / coat meter for checking the DFT of paint. The purchaser /Inspector may at his discretion, check the test results obtained at the Contractor's works, by independent test at the Government Test House or elsewhere, and should the material so tested be found to be unsatisfactory, the cost of such test shall be borne by the Contractor.

6.10.3 Contractor shall make all necessary arrangements for stage inspection by purchaser/Inspector during the fabrication at shop and incorporate all on-the-spot instructions / changes conveyed in writing to the Contractor.

6.10.4 Material improperly detailed or wrongly fabricated shall be reported to the Purchaser/Inspector and shall be made good as directed. Minor misfits which can be remedied by moderate use of drift pins, and moderate amount of reaming and slight chipping may be corrected in that manner; if in the opinion of the Purchaser/Inspector the strength or appearance of the structure will not be adversely affected. In the event the Purchaser/Inspector directs otherwise, the items will be rejected and a completely new piece shall be fabricated. The cost of correcting errors shall be to the account of the Contractor.

6.10.5 The Purchaser/Inspector shall have the power:

- To certify, before any structure is submitted for inspection, that the same is not in accordance with the contract, owing to the adoption of any unsatisfactory method of fabrication.
- To reject any structure as not being in accordance with specifications & drawings.
- To insist that no structure or parts of the structure once rejected is resubmitted for inspection/ test, except in cases where the Purchaser / Inspector/ authorised representative considers the defects as rectifiable.

6.10.6 If, on rejection of structure by the Purchaser/Inspector the Contractor fails to make satisfactory progress within the stipulated period, the Purchaser/Inspector shall be at liberty to cancel the contract and fabricate or authorise the fabrication of the structures at any other place he chooses, at the risk and cost of the Contractor, without prejudice to any action being taken in addition to terms of General Conditions of Contract.

6.10.7 The Purchaser / Inspector's decision regarding rejection shall be final and binding on the Contractor.

6.10.8 The specifications prescribe various tests at specified intervals for ascertaining the quality of the work done. If the tests prove unsatisfactory, Purchaser/Inspector shall have liberty



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to order the Contractor to re-do the work, done in that period and/ or to order such alterations and strengthening that may be necessary at the cost of the Contractor. The contractor shall be bound to carry out such orders failing which the rectification/redoining will be done by the Purchaser through other agencies and the cost recovered from the Contractor.

6.10.9 Notwithstanding any inspection at the workshop, the Purchaser/Inspector shall have the liberty to reject, without being liable for compensation any fabricated members or materials brought to site that do not conform to specifications / drawings.

6.10.10 The Purchaser/Inspector shall issue inspection certificates to the contractor for the structures found acceptable.

6.11 WASTAGE (as applicable)

For the purpose of accounting of materials supplied by Purchaser, free or on cost recoverable basis, the permissible wastage shall be as specified in GCC / SCC of the purchaser.

All rejected materials shall be removed from the site of fabrication by the Contractor at his own cost and within the time stipulated by the Purchaser/Inspector.

6.12 ACCEPTANCE CRITERIA OF PLANED/ MACHINED SURFACE

6.12.1 Standard of acceptance for planed/machined surfaces, wherever specified by designer; (e.g. in end bearing plates of crane girders, base plates and column shafts etc.) shall be as given as per following.

6.12.2 Maximum surface unevenness on bearing surface of cap/ base plate shall not exceed 0.5 mm.

6.12.3 When assembled, there must be physical contact for at least 75% of the contact surface.(The checking shall be carried out with 0.2mmgauge . Care should be taken that these connecting members are fixed with such accuracy that they are not reduced in thickness during machining by more than 1.0 mm.

6.13 DESPATCH INSTRUCTIONS

6.13.1 Each despatch able structure/member shall bear mark no. along with reference drawing number at two prominent locations (e.g. on flange and bottom of base plate of a column).

6.13.2 Any Item to be despatched to erection site must be accompanied with its Inspection Certificate.

6.13.3 "As built" drawing shall be prepared after fabrication is completed to indicate additions / alterations made during the process of fabrication.

6.13.4 Control assembly of important structures shall be done in the shop floor before despatch to avoid mismatching. For all such important structures, match marking shall be given at the control assembly stage in the shop floor and such match markings shall be made clearly visible while assembling the structures at site.



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6.13.5 Centre lines of column flanges and both sides of web shall be punched, preferably at top and bottom to facilitate alignment after erection.

6.13.6 The Contractor is solely responsible for any loss or damage during transit to any of the fabricated members, and as such proper precautions shall be taken by him to guard against such mishaps.

6.13.7 The Contractor shall submit periodic test reports of all materials procured and used such as raw steel, paints, electrodes, colour coated sheets, poly carbonate sheets, sheeting fixtures, bolts, nuts & washers etc. The test reports shall indicate conformance to specifications / IS codes etc.

6.13.8 The Contractor shall submit test reports for all welds carried out at shop such as UT and RT reports, shall also be submitted along with each inspection call, covering structures offered for inspection.

6.13.9 DFT record of paint applied measured at random covering structures offered for inspection.

6.14 COMPLETION DOCUMENTS

6.14.1 On completion of work, the Contractor shall submit to the Purchaser the following documents.

- Scanned copy of all working drawings duly certified by the Purchaser/Consultant.
- Copies of the "As built" drawings showing thereon all additions and alterations made during the fabrication.
- Manufacturer's test certificates for all bought-out items including raw steel.
- Copies of Radio graphic test reports for all welds along with Films.

SECTION - 7: ERECTION OF STEEL STRUCTURE

7.1 SCOPE OF WORK

The scope of work under erection includes, but not limited to, the following:

- a) Supply of tools and tackles, consumables including bolts & HT bolts, materials, labour and supervision.
- b) Receiving, unloading, checking and moving into storage at site including attending to insurance matters as necessary for all materials arriving at site.
- c) Storing and stacking of all fabricated structural components/units/assemblies at site storage yards till the time of erection.
- d) Transportation of structures from storage yard to site of erection, including multiple handling, if required.
- e) All minor rectification / modifications.



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- f) Removal of bends, kinks, twists etc. for parts damaged during transportation and handling.
- g) Reaming of holes which do not register or which are damaged, for use of next higher size bolt.
- h) Plug-welding and re-drilling of holes which do not register and which cannot be reamed for use of next higher size bolt.
- i) Drilling of holes which are either not drilled at all or are drilled in incorrect position during fabrication.
- j) Fabrication of minor missing items as directed by the purchaser.
- k) Verification of the position of embedded anchor bolts and inserts with respect to benchmarks/ based on Geodetic Scheme. Survey of mating surface w.r.t. position & level
- l) Assembly at site of steel Structural components wherever required, including temporary supports and staging.
- m) Making arrangements and bearing cost for providing all facilities for conducting ultrasonic, X-ray or gamma ray tests of welds; getting the tests conducted by reputed testing laboratories making available test films / graphs, reports and interpretation.
- n) Rectification at site damaged portions of shop primer by cleaning and application of primer and touch-up paint.
- o) Erection of structures including making connections by bolts / High Strength Friction Grip bolts/welding as per drawing.
- p) Alignment of all structures true to line, level, plumb and dimensions within specified limits of tolerance.
- q) Application at site after erection, required number of balance coats of primer, intermediate and finishing paint as per specification and drawing. r) Rectification of structures as per Preliminary acceptance report and Final acceptance report.

7.2 STORAGE AND HANDLING

7.2.01 Storage of structures shall be preferably be done in such a manner that erection sequence is not affected.

7.2.02 While storing, care shall be taken so that structures do not come in direct contact with the earth surface and accumulated water. Girders, beams, columns shall be placed and stored in such a manner that during rain, no accumulation of water on the structures takes place.

7.2.03 Stacking of the structures shall be done in such a way that, erection marks are visible easily and handling does not become difficult. Wherever required, wooden sleepers / grilles may be used.

7.2.04 Handling and storage of materials shall be as per IS: 7969-1975, to ensure safety.

7.3 GENERAL INSTRUCTIONS FOR ERECTION



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7.3.1 Erection procedure for erection of temporary structures, to support pipelines, or other loads resting on existing structure which is required for dismantling or strengthening, shall be submitted for review / approval to consultant/client.

7.3.2 Erection procedure for new structures shall be submitted for review / approval to consultant/client.

7.3.3 Erection shall be carried out in accordance with IS: 800 and other relevant standards referred to therein apart from this specification.

7.3.4 The Contractor shall be responsible for checking the alignment and levels of foundations, correctness of foundation; centres of anchor bolts etc. well in advance of starting erection work and shall be responsible for any consequence for non-compliance thereof. Discrepancies, if any, shall immediately be brought to the notice of the Purchaser. Any mistake subsequently found in alignment and levels of the structural steelwork due to non-verification of foundation before erection shall be corrected by the Contractor at his own expense.

7.3.5 One set of reference axes and one bench mark level will be furnished to the Contractor. These shall be used for setting out of structures. Maintenance of such bench mark level shall be the responsibility of the Contractor.

7.3.6 The Contractor at his own expenses shall provide measuring instruments for setting out, levelling and aligning steelwork. He shall provide one exclusive survey team for alignment of structural works.

7.3.7 For safe and accurate erection of structural steelwork, staging, temporary support, false-work etc. shall be erected as required.

7.3.8 All erection works shall be done with the help of cranes, use of derrick is not envisaged.

7.3.9 Erection should start preferably from braced bays.

7.3.10 The fabricated materials received at erection site shall be verified with respect of marking on the key plan/marketing plan or shipping list.

7.3.11 Any material found damaged or defective shall be stacked separately and the damaged or defective portions shall be painted in distinct colour for identification and the same shall be brought to the notice of the Purchaser.

7.3.12 The approved erection drawings and any approved arrangement drawing, specification or instruction accompanying them shall be followed in erecting structures.

7.3.13 Erection work shall be taken up after receipt of clearance from the purchaser.

7.3.14 For safety requirements during erection, provisions in IS: 7205 - 1974, IS:7969 - 1975 and other relevant Indian standards shall be followed.

7.3.15 Erection shall be carried out with the help of maximum mechanisation possible.

7.3.16 Prior to commencement of erection, all the erection equipment, tools, tackles, ropes etc. shall be tested for their load carrying capacity. Such tests may be repeated at intermediate



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stages also if considered necessary and frequent visual inspection shall be done of all vulnerable areas and components to detect damages or distress in the erection equipment, if any.

7.3.17 Temporary bracing, whenever required, shall be provided to sustain forces due to erection loads and equipment etc. Erected parts of the structures shall remain stable during all stages of erection when subjected to the action of wind, dead weight and erection forces etc. Specified sequence of erection of vertical and horizontal structural members shall be followed. Erected members shall be held securely in place by bolts / guy ropes etc. to take care of dead load, wind load and erection load during all stages of erection, alignment, welding & painting.

7.3.18 All connections shall achieve free expansion and contraction of structures wherever provided.

7.3.19 No final bolting or welding of joints shall be done until the structure has been properly aligned. Structures shall be aligned true to plumb and level and shall be checked by using theodolite and a scheme shall be submitted for approval of the purchaser. Final welding / bolting shall be done only after obtaining approval of the alignment scheme from the purchaser.

7.3.20 Welding shall be carried out as specified in the Chapter "Welding of Steel Structures" in this specification.

7.3.21 All erection bolts shall be retained in position or the holes shall be plug welded. No unused holes shall be left.

7.3.22 For positioning beams, columns and other steel members, the use of steel sledges is not permitted.

7.3.23 Instrumental checking of correctness of initial setting out of structures and adjustment of alignment shall be carried out in sequence and at different stages as required, by deploying independent survey team. The final levelling and alignment shall be carried out immediately after completion of each section of a building using survey instruments.

7.3.24 All structural members shall be erected with erection marks in the same relative position as shown in the appropriate erection and shop drawings.

7.3.25 The contractor shall manufacture, erect and provide false-work, staging temporary support etc. required for safe and accurate erection of structural steel work and shall be fully responsible for the adequacy of the same in strength for transferring temporary and erection loads.

7.3.26 The Contractor shall also provide facilities such as adequate temporary access ladders, gangways, tools & tackles, instruments etc. to purchaser for his inspection at any stage during erection.

7.3.27 All materials & consumables shall confirm to the specification in Annexure-E.

7.3.28 Notwithstanding any assistance rendered to the Contractor by the Purchaser, if at any time during progress of the Work, any error should appear or rise therein, on being required to



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do so, Contractor at his own cost shall remove and amend the work as directed by the Purchaser.

7.3.29 The contractor shall fully abide by the safety procedures and any accident whatsoever concerned to erection shall be full responsibility of the contractor.

7.4 FIELD CONNECTIONS

7.4.1 The numbers of washers on permanent bolts shall be one for the bolt head side and one or two for the nut side.

7.4.2 Where bolting is specified on the drawing, the bolts shall be tightened to the specified limit. The threaded portion of the each bolt shall project through the nut by at least three threads. Tapered washers shall be provided for all heads and nuts to achieve uniform bearing on sloping surface. Minimum two bolts shall be provided at any bolted connection.

7.4.3 To prevent loosening of nuts, spring washers or lock-nuts shall be provided as specified in the design/shop drawings.

7.4.4 All machine-fitted bolts shall be perfectly tight and the ends shall be checked to prevent nuts from becoming loose. No unfilled holes shall be left in any part of the structures.

7.4.5 All field assembly by welding shall be executed in accordance with the requirements for shop fabrication. Where the steel has been delivered painted, the paint shall be removed before field welding for a distance of at least 50 mm on either side of the joints to be welded.

7.4.6 The mating surfaces shall be prepared in accordance with the requirements of design in order to achieve required properties to develop adequate friction between the surfaces.

7.4.7 The mating surfaces shall be absolutely free from grease, lubricant, dust, rust etc. and shall be thoroughly cleaned before assembly.

7.4.8 The nuts shall be tightened up-to the specified torque with the help of torque -wrench or by half- turn method with the help of pneumatic wrench lever.

7.4.9 The direction of tightening of the nuts shall be from the middle toward the periphery of assembly.

7.4.10 after desired tightening the bolt heads, nuts and edges of the mating surfaces shall be sealed with a coat of paint to obviate entry of moisture.

7.5 ACCEPTANCE STANDARD OF WELDING

7.5.1 Acceptance standard of welding shall be as specified in “Welding of Structures” section of this specification.

7.6 BEDDING AND GROUTING

7.6.1 Base plates shall be set to elevations shown on the drawings, supported aligned and levelled using steel wedges and shims or by other approved methods. Plates shall be levelled properly, positioned and the anchor bolts tightened.



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7.6.2 Pack plates below base plates should cover at least 50% area of the base plate unless noted otherwise and all such material shall be accounted as per special conditions of contract.

7.6.3 The gap between the base plate and the foundation shall be pressure grouted by approved method, after thorough cleaning of the gap, duly checked by site Engineer. The concrete mix shall be minimum M30 or as per instruction / drawings and to be supplied by the contractor. Such grouting shall be carried out strictly under the supervision of site Engineer.

7.6.4 Bedding/grouting shall not be carried out until sufficient number of columns have been properly aligned, levelled and plumbed and sufficient number of girders, beams, trusses and bracings have been put in position & accepted by the purchaser.

7.7 PAINTING AFTER ERECTION

The painting shall be as per "Surface preparation and painting of steel structures" section of this specification and instructions stated in the drawings.

7.8 ERECTION TOLERANCES

Maximum permissible tolerances in erected steel structures shall be as given in ANNEXURE-D

7.9 GUIDELINES FOR SAFE ERECTION PRACTICE:

(a) DO'S

- (1) Carry out erection only after structures are thoroughly inspected and cleared.
- (2) Start erection from braced bay.
- (3) Ensure proper packing below the columns to have correct levels (to be checked by survey schemes)
- (4) Ensure proper anchoring of column base by tightening of all anchor bolts.
- (5) Ensure that guying is done at 2/3rd height in 3 directions 120degree apart.
- (6) Ensure that guy ropes are fully tight and anchored .Size of the guy rope should be adequate to take loads
- (7) Provide temporary bracing wherever needed.
- (8) Outstanding of flanges of beams /columns are to be protected against local bending at location of slinging during erection.
- (9) Ensure that cross beam/bracings are erected only after the cleats/gussets are fully welded.
- (10) Do the welding of cross beams with cleats, only after ensuring all bolts are in position and are tightened fully.

(b) DON'TS

- (1) Don't leave the structures without proper guying in all directions till they are braced.



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- (2) Don't miss to anchor properly at the base of columns with anchor nuts fully tightened.
- (3) Don't use manila ropes in place of steel ropes for guying.
- (4) Don't support the cross beams with temporary jigs. Ensure all the bolts are provided and tightened.
- (5) Don't use bracings/tie members for fixing lifting tackles/diversion pulleys/cable trays to avoid damages due to erection loads.
- (6) Avoid indiscriminate cutting/notching of erected and loaded structures.
- (7) Don't use column bases for anchoring guy ropes of structures.

7.10 ACCEPTANCE OF WORK

Acceptance of erected steel structures shall be either after completion of erection of the whole building or in blocks.

7.11 DOCUMENTATION

7.11.1 The following documents shall be presented/ submitted at the time of acceptance of erected structures.

- i) Deviations, if any, observed in foundations, anchor bolts etc.
- ii) Documents showing actual deviations made during execution of erection work and approval of competent authority.
- iii) Alignment schemes prepared, verified by qualified surveyor and approved by purchaser.
- iv) Copies of site modification sketches, test reports of all welds tested during erection.
- v) Documents showing acceptance of embedded structures.
- vi) Test reports of all materials procured and used such as paints, electrodes, colour coated sheets, poly carbonate sheets, bolts, nuts & washers etc. The test reports shall indicate conformance to specifications / IS codes etc.
- vii) Copies of Radiographic Test reports for welds carried out at site along with films..
- viii) DFT record of paint applied measured at random for each area of structures shall be submitted.
- ix) Soft copies of "As-Built" drawing showing thereon all additions and alternations, which took place between approval of drawing and erection of structures.



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SECTION – 8: WELDING OF STEEL STRUCTURES

8.0 GENERAL INSTRUCTION FOR WELDING

8.1.1 The Contractor shall work out welding procedure for the structures at his own responsibility and submit for Purchaser's/ consultant's information, considering the following factors.

- a) Specification and thickness of steel.
- b) Specification of electrode or/and base wire.
- c) Welding process (manual arc welding, submerged arc welding).
- d) Type of structures to be welded (thickness of components meeting at a joint).
- e) Pre and post heating requirement.
- f) Preparation of fusion faces.
- g) Sequence of welding.
- h) Weather condition.
- i) Use of jigs and fixtures etc.
- j) Type of non-destructive testing to be carried out.



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k) Inspection procedure to be followed.

l) Design requirements of the joints.

8.1.2 Welding of any load bearing structure shall be carried out only by the person who has passed welder's qualification as per IS: 7318 (Part-I).

8.1.3 Contractor shall employ competent supervisors, exclusively for welding works, to ensure that the standard of workmanship and quality of materials comply with requirements of this specification.

8.1.4 All metal arc welding shall be carried out as per IS: 9595-1996

8.1.5 Submerged arc welding of mild steel and low alloy steel shall be as per IS: 4353-1995

8.1.6 Electrode shall conform to as specified in ANNEXURE- E of this specification.

8.1.7 Purchaser may at his own discretion order periodic tests of the Welders and/or of welds produced by them. Such tests shall be at the expense of the Contractor.

8.1.8 Electrodes shall be stored in a dry place. Electrodes whose coatings are damaged due to absorption of moisture or due any other reason shall not be used.

8.1.9 Low Hydrogen electrodes and flux for submerged welding shall be dried at 250°-300° C for one hour in drying even before use.

8.1.10 For suitability of wire flux combination, procedure test shall be carried out as per IS: 3613-1974 if so required.

8.1.11 Welding shall be done by electric arc process. Generally submerged arc, automatic & Semi-automatic welding shall be employed. Only where it is not practicable, manual arc welding may be resorted to. In case of manual arc welding, recommendations of electrode manufacturer are to be strictly followed.

8.1.12 After completing each run of weld, all slag should be thoroughly removed and surface cleaned before starting the next run of weld. The weld metal as deposited (including tack welds if to be incorporated) shall be free from cracks, slag, inclusions, gross porosity, cavities and other deposition faults. The weld metal shall be properly fused with the parent metal without serious undercutting or overlapping at the toes of the weld. The surfaces of the weld shall have a uniform and consistent contour and uniform appearance.

8.1.13 Fillet weld shall have the correct profile with smooth transition into parent metal. Dressing of welds, if specified, shall be done by such method, which does not cause grooving and other surface defects on the weld or on the parent metal.

8.1.14 All butt welds shall start and end with run-on and run-off plates. All such plates shall be carefully trimmed off by gas cutting after welding is over.

8.1.15 Fillet welds shall not be stopped at corners but shall be returned round them.



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8.1.16 If butt weld is to be ground flush with the surface of the member as per drawing. Adequate reinforcement shall be built up and then the same shall be chipped off and ground flush. The grinding is to be done in the direction of stress flow till the transverse marks are eliminated.

8.1.17 Welding shall not be done under such weather conditions, which might adversely affect the efficiency of the welding and arc-strikes on parent surfaces of structures shall be strictly avoided.

8.1.18 Manipulators shall be used wherever necessary and shall be designed to facilitate welding and ensure that all welds are easily accessible to the operators.

8.1.19 Stress relieving after welding shall be done if especially called for in the drawing or specification. Ends of structural members and portions of gussets receiving welding at site shall be left unpainted.

8.1.20 Permissible deviation in assembly of weld joints shall be in accordance with Annexure-C.

8.2 CONTROLS IN WELDING

8.2.1 The extent of quality control in respect of welds for structural elements for both statically and dynamically loaded structures shall be as follows and shall be conducted by the contractor at his own cost. Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.

a) Visual Examination

All welds shall be 100% visually inspected to eliminate the following defects like Presence of undercuts, Visually identifiable surface cracks in both welds and base metals, Unfilled craters, Improper weld profile and size, excessive reinforcement in weld, Surface porosity etc.

b) Dye Penetration Test (DPT)

This shall be carried out in accordance with IS: 11732 – 1995, used for steel castings, for all important fillet welds and groove welds for both statically and dynamically loaded structures to check the following like Surface cracks, Surface porosity. Severity Level 3 shall be considered for acceptance.

c) Ultrasonic testing

Ultrasonic test shall be conducted for all groove welds and heat affected zone in dynamically loaded structures and for other important load bearing butt welds in statically loaded structures as desired by purchaser, to detect the following like Cracks, Lack of fusion, Slag inclusions, Gas porosity.

All butt welds shall be tested for 100 % length by Ultrasonic tests and report shall be submitted.

Ultrasonic testing shall be carried out in accordance with American National Standard ANSI/AWS D1.1-96 Chapter -6: Part F.



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Before ultrasonic test is carried out, any surface irregularity like undercuts, sharp ridges etc. shall be rectified. Material surface to be used for scanning by probes must allow free movement of probes. For this purpose, surface shall be prepared to make it suitable for carrying out ultrasonic examination.

d) Radiographic Testing (X-ray and Gamma-Ray Examination)

This test shall be conducted to a minimum of 2% of length of welds of each element of each butt joint for welds made by manual or semiautomatic welding and 1 % of length of weld if made by automatic welding machines. The location and extent of weld to be tested by this method shall be decided by purchaser to detect the following defects like gas porosity, slag inclusions, lack of penetration, lack of fusion, cracks.

Radiographic testing shall be conducted in accordance with American National Standard ANSI/AWS D1.1-96 Part E.

Any surface irregularity like undercuts, craters, pits etc. shall be removed before conducting radiographic test. The length of weld to be tested shall not be more than $0.75 \times$ focal distance. The width of the radiographic film shall be width of the welded joint plus 20 mm on either side of the weld.

Before inspection, the surface of weld metal shall be cleaned of all slag, spatter matter; scales etc. by using wire brush or chisel.

8.3 ACCEPTABLE LIMITS OF DEFECTS IN WELD

8.3.1 Limits of Acceptability of welding defects shall be as follows.

a) Visual inspection & Dye Penetration Test –

The limits of acceptability of defects detected during visual inspection and Dye Penetration Test shall be in accordance with clauses 6.9 & clause 6.10 of American National Standard ANSI/AWS D1.1-96 for statically as well as dynamically loaded structures respectively.

b) Ultrasonic Testing –

The limits of acceptability of defects detected during ultrasonic testing shall be in accordance with clause 6.13.1 & clause 6.13.2 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C for statically and dynamically loaded structures respectively.

c) Radiographic testing –

The limits of acceptability of defects detected during Radiographic testing shall be in accordance with clauses 6.12.1 & 6.12.2 of American National Standard ANSI/AWS D1.1-96 Chapter 6: Part C for statically and dynamically loaded structures respectively.

8.4 RECTIFICATION OF DEFECTS IN WELDS

8.4.1 In case of detection of defects in welds, the rectification of the same shall be done as follows.



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- a) All craters in the weld and breaks in the weld run shall be thoroughly filled with weld.
- b) Undercuts, beyond acceptable limits, shall be repaired with dressing so as to provide smooth transition of weld to parent metal.
- c) Welds with cracks and also welds with incomplete penetration, porosity, slag inclusion etc. exceeding permissible limits shall be rectified by removing the length of weld at the location of such defects plus 10 mm from both ends of defective weld, and shall be re-welded. Defective weld shall be removed by chipping hammer, gouging torch or grinding wheel. Care shall be taken not to damage the adjacent material.

SECTION – 9: SURFACE PREPARATION AND PAINTING OF STEEL STRUCTURES

9.1 SURFACE PREPARATION FOR PAINTING

9.1.1 The steel surface which is to be prepared shall be cleaned of dirt, welding flux, scale, oil and grease and the heavier layers of rust shall be removed by grinding prior to actual surface preparation to a specified grade.

9.1.2 Surface preparation to be followed prior to painting shall be based on the requirement of a particular painting system adopted. One of the following specifications for surface preparation is to be followed as per requirement.

9.2 GRADES OF MECHANICAL CLEANING

9.2.1 Mechanical cleaning shall be done manually or using power as per grade St-2 or St-3 of IS: 9954.

a) Grade St-2: Thorough scraping and wire brushing, machine brushing, grinding etc. This grade of preparation shall remove loose mill scale, rust and foreign matter. Finally the surface is to be cleaned with a vacuum cleaner or with clean compressed air or with clean brush. After preparation, the surface should have a faint metallic sheen. The appearance shall correspond to the prints designated St-2.

b) Grade St-3: very thorough scraping and wire brushing, machine brushing, grinding etc. The surface preparation is same as for grade St-2 but to be done much more thoroughly. After



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preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3.

9.2.2 If no grade of surface preparation is specified, Grade St-2 as specified above shall be followed.

9.3 GRADES OF BLAST CLEANING

9.3.1 Blast cleaning shall be done by shot blasting as per following grades according to IS: 9954.

Grade Sa-2½: This involves very thorough blast cleaning. Mill scale, rust and foreign matter shall be removed to the extent that the only traces remain in the form of slight stains. Finally the surface is cleaned with vacuum cleaner, clean dry compressed air or a clean brush. It shall then correspond in appearance to the prints designated as Sa 2½.

9.4 GENERAL INSTRUCTIONS FOR PAINTS AND PAINTING

9.4.1 For use of specific painting system, the paint manufacturer's specification shall prevail.

9.4.2 General compatibility between primer and finishing paints shall be established through the paint manufacturer supplying the paints.

9.4.3 The colour scheme to be followed for various types of steel structures is detailed in Annexure-G.

9.4.4 Before buying the paint in bulk, it is recommended to obtain sample of paint and painting shall be carried out in the presence of manufacturer of paint after carrying out surface preparation. Paint coverage / DFT obtained etc. shall be compared with manufacturer's catalogue.

9.4.5 In order to ensure that the supplied paint meets the stipulation in design drawing/ specification, if required, samples of paint shall be tested in laboratories to establish quality of paint with respect to (i) Viscosity (ii) adhesion/ bond of paint in steel surfaces (iii) adhesion/simulated salt spray test (iv) chemical analysis (percentage of solids by weight) (v) normal wear resistance as encountered during handling & erection (vi) resistance against exposure to acid fumes etc. Whole quantity of paint for a particular system of paint shall be obtained from the same manufacturer.

9.4.6 Thinners, wherever used, shall be as per recommendation of the paint manufacturer. All ingredients shall be thoroughly mixed. Mixing by air bubbling is not permitted. All pigmented paints shall be strained after mixing to remove skims and other undesirable matters.

9.4.7 Areas, which become inaccessible after assembly of structures, shall be painted before assembly, after cleaning the surfaces as specified. 9.4.8 Wherever shop primer painting is scratched, abraded or damaged, the surfaces shall be thoroughly cleaned using emery paper and power driven wire brush wherever warranted, and touched up with corresponding primer. Touching up paint shall be matched and blended to eliminate conspicuous marks.



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9.4.9 If more than 50% of the painted surface of an item requires repair, the entire item shall be mechanically cleaned and new primer coats shall be applied followed by finishing coats as per painting specification.

9.4.10 All field-welded areas on shop painted item shall be mechanically cleaned (including the weld area proper, adjacent areas contaminated by weld spatter or fumes and areas where existing primer. intermediate / finishing paint is burnt). Subsequently, new primer and finishing coats of paint shall be applied as per painting specification.

9.4.11 Application of paint shall be by spraying or brushing as per IS: 487 and in uniform layers of 50% overlapping strokes. Painting shall not be done when the temperature is less than 5°C or relative humidity more than 85%, unless manufacturer's recommendations permit. Also painting shall not be done in frosty or foggy weather. During application, paint agitation must be provided wherever such agitation is recommended by the manufacturer.

9.4.12 Paint shall be applied at manufacturer's recommended rates. The number of coats shall be such that the minimum dry film thickness (DFT) specified is achieved. The dry film thickness of painted surfaces shall be checked with Electrometer or measuring gauges to ensure application of specified DFT.

9.4.13 All structures shall receive appropriate number of primer, intermediate and finishing coats in order to achieve overall DFT as per design drawings/ specifications. First coat of primer paint shall be applied not later than 2-3 hours after preparation of surface, unless specified otherwise.

9.4.14 Intermediate coat (MIO) if any, shall be applied within seven days of application of previous coat for better adhesion.

9.4.15 The finishing paint as specified shall be of approved colour and quality. The under coat shall have different tint to distinguish the same from the finishing coat.

9.4.16 Edges, corners, crevices, depressions, joints and welds shall receive special attention to ensure that they receive painting coats of the required thickness.

9.4.17 Parts of surfaces embedded in concrete shall be thoroughly cleaned of grease, rust, mill scale etc. and shall be given a protective coat of Portland cement slurry immediately after fabrication. No paint shall be applied on this part.

9.4.18 Zinc-rich primer paints, which have been exposed several months before finishing coat is applied, shall be washed down thoroughly to remove soluble zinc salt deposits. In similar circumstances, the surfaces of paint based on epoxy resin should be abraded or lightly blast cleaned to ensure adhesion of next coat.

9.4.19 Surfaces which cannot be painted but require protection shall be given a coat of rust inhibitive grease according to IS: 958-2000 or equivalent international standard.

9.4.20 MS gratings shall be painted by dipping in a paint tub.

9.5 PAINTING SYSTEM



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The recommended painting system for general service requirement of steel structures covering surface preparation, application of primer coats, intermediate coats (if necessary) and final coats to develop the required minimum dry film thickness on steel surface is indicated below.

Out of the two coats of primer paint, one coat of primer shall be applied at fabrication shop. The remaining all other coats of paint shall be applied during erection, welding & liquidation of defect list as per site requirements.

9.5.1 PAINT SYSTEM-P1 – FOR EXISTING & RECTIFIED STRUCTURES

All EXISTING & RECTIFIED structures shall be painted as per following scheme:

- i) Surface preparation confirming to Grade St-3 of IS: 9954 very thorough scraping and wire brushing, machine brushing, grinding etc. The surface preparation is same as for grade St 2 but to be done much more thoroughly. After preparing the surface, it should have a pronounced metallic sheen and correspond to the prints designated St-3.
- ii) Primer Paint – One coat of tolerant high build epoxy primer with volume solid of 84% (DFT = 125 microns).
- iii) Intermediate Paint - One coat Application of Intermediate of Cycloaliphatic Amine adduct epoxy phenolic coating with volume solid of 80% (DFT = 150 microns).
- iv) Finishing paint – Two coats of Finishing paint of Acrylic Polyurethane with volume solid 57% (DFT = 40 microns per coat) of approved colour.

(Total DFT=355 microns minimum)

9.5.2 PAINT SYSTEM-P2 – FOR NEW STRUCTURES

All NEW structures shall be painted as per following scheme:

- i) Surface preparation by shot blasting confirming to Swedish Standard SA 2½ according to IS:9954.
- ii) Primer Paint – One coat Application of Inorganic Zinc Silicate with volume solid of 65% (DFT = 75 microns).
- iii) Intermediate Paint - One coat Application of Intermediate of Cycloaliphatic Amine adduct epoxy phenolic coating with volume solid of 80% (DFT = 150 microns).
- iv) Finishing paint – Two coats of Acrylic Polyurethane of approved colour with volume solid 57% (DFT = 40 microns per coat).

(Total DFT=305 microns minimum)



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SECTION 10 – SPECIAL ASPECTS TO BE NOTED

10.1 QUOTATION

10.1.1 The contractor should ascertain himself, by a visit to the site if necessary, the actual site conditions, local factors etc. The Contractor shall bear full responsibility for deductions and conclusions as to the nature and conditions under which the work is to be executed, including effect of climate, rainfall etc. Failure to do so will not absolve the Contractor of his responsibilities about the proper execution of the job. No claims for extra payments due to any special site conditions and ignorance of site conditions will be considered after the acceptance of his quotation.

10.1.2 Contractor has to make a thorough erection planning taking into consideration, the works of other departments like civil, mechanical, electrical etc. working in the erection area, so that erection of any structure is not hampered due to ongoing works of other departments.

10.1.3 Contractor shall confirm their clear acceptance of Structural Technical Specification in totality with no deviation from the same, and submit a copy of Structural TS duly signed on each page as token of acceptance.

10.1.4 The enclosed bid drawings / description as given TS are deemed to be sufficient for the contractor to assess the nature and quantity of work involved and to quote his prices for the above job. No payment on account of deviations from the bid drawings will be admissible.



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10.1.5 The cost & weight of MS bolts / High strength bolts (permanent and erection), pack plates under columns, shims, washers, electrodes, putty, gases, cost of straightening the raw materials (hot bending not permitted), cutting of flats from plates and providing splices, paints, tool, plants, etc. as required for the work shall be deemed to be included in the quoted price.

10.1.6 All handling and transport charges of raw materials and fabricated structures, including double / multiple handling if required, for completion of the work in accordance with time schedule are deemed to be included in the quoted price.

10.1.7 Cost of NDT of welds as per specification, irrespective of film length shall be borne by the Contractor. For the welds found defective, the cost of retest shall be borne by the contractor in addition to the cost of rectification or replacement of the defective part.

10.2 DIVISION OF WORK

10.2.1 Purchaser shall have the right to divide and award the work in this Invitation to Bid, to more than one Contractor.

10.3 PROGRAMME

10.3.1 A monthly time bar chart for various activities like procurement of steel, preparation and approval of fabrication drawings, fabrication, despatch to site, erection and alignment, sheeting and painting etc. giving starting and completion dates of all activities, shall be submitted along with the bid without which the bid may not be considered for evaluation.

10.3.2 The contractor shall also furnish his overall planning of construction programme, the capacity of equipment he proposes to deploy on various components of work etc. for prior approval of purchaser.

10.3.3 The contractor shall also furnish details of proposed list of equipment to be deployed / supervisory staff / engineers for each activity of the job such as planning, quality control, fabrication, erection, inspection, painting, billing etc

10.3.4 The contractor shall furnish proposed pro-rata deployment of labour per 100 t of fabrication and 100 t of erection per month.

10.3.5 All programmes on procurement of raw steel and other materials, preparation of drawings, fabrication and despatch shall match with the sequence of erection of different structural components and different building/units, of the project as per network planning.

10.3.6 The purchaser may change or alter the detailed working programme for the sequence of work and for the fabrication of components of structures, within the frame work of the agreed schedule, which will be binding on the Contractor.

10.3.7 If due to design or other stipulations in the bid or requirements at site, a particular sequence of overall construction has to be followed due to which certain interruptions to any one or more items of work are inherent, no claims for such interruption will be admissible.

10.4 MATERIAL



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10.4.1 The Contractor shall arrange and procure all steel sections, plates, Paints Colour coated troughed sheets, flashings, fixtures and fittings required for sheeting and glazing, aluminium or MS astragals and frames for glazing, clips, Insulated panels all the consumables like bolts, turned and fitted bolts, nuts including spares and service bolts, washers of different types, electrodes, gas, shims, packs, paints, etc. for completing the work satisfactorily and the cost of the same shall be deemed to have been covered in his quoted price.

10.4.2 If assistance is required by the Contractor in obtaining permits/proprieties in allotment of controlled/scarcie materials, if any, the same may be extended by the Purchaser by way of issue of recommendation letter, essentiality it certificate etc. to Government Authorities. Delay, if any, in obtaining the materials will not constitute a ground for claiming any compensation or extension of time.

10.4.3 Where any raw materials required for the execution of the contract is procured with the assistance of the Purchaser or permit /license /quota certificate or release order issued by or on behalf of or under authority of Purchaser or by any officer empowered on their behalf by law, or where advance payments are made to the Contractor to enable him to purchase such raw material for execution of work, the Contractor:-

- a) Shall hold such materials as trustee for the Purchaser.
- b) Shall use such materials economically and solely for the purpose of the contract.
- c) Shall not dispose of the same without prior permission in writing from the Purchaser.
- d) Shall maintain and produce due documents indicating stock position / consumption of such materials from time to time, as required by purchaser.

10.4.4 The Purchaser may plan to procure and supply from the producers/stockyards major items of structural steel such as RS Joists, channels, angles, plates etc., required for the work. In that case these will be supplied to the Contractor in the indented lengths or standard lengths available, as received from the suppliers.

10.4.5 When steel is to be supplied by Purchaser, the Contractor shall be made the consignee for receiving all such steel materials. On receipt of materials at the nearest rail head, he shall be responsible for clearing, unloading and transporting the materials to his stockyards/place of work at his own cost. All demurrage due to any delay in clearing and /or unloading the steel materials shall be borne by the Contractor. The Contractor shall keep the purchaser informed of the receipt of materials regularly.

10.4.6 When material is issued from Purchaser's stores, the Contractor shall be responsible for taking delivery at the stores and make his own arrangement for transporting the materials to the place of work.

10.4.7 Purchaser reserves the right to take back such sections or quantity of steel issued in excess of the quantity as per Fabrication drawings plus permissible wastage. The Contractor shall return to the Purchaser all such steel supplied in good and acceptable condition. In case of failure of the Contractor to return such surplus steel on demand by Purchaser, Purchaser



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reserves the right to recover the cost of such steel at 20% above the prevailing SAIL's stockyard rates inclusive of all taxes.

10.4.8 In case the steel is procured by the Contractor, test certificates for the same shall be made available to the Purchaser.

10.5 CONTRACTOR'S RESPONSIBILITY

10.5.1 The Contractor shall at his own cost make his own site office with storage space for proper storage of all materials brought by him to the work site/ Fabrication shop to prevent damage due to rain, wind, direct exposure to sun etc. and also from theft/pilferage etc.

10.5.2 The structures shall have to be erected suitably detailed with erection of equipment or construction of civil works. The Contractor shall ensure spirit of co-operation with other contractors and strict adherence to the schedule so that erection schedules of the other parties are not affected.

10.5.3 Providing/arranging all necessary drawings/documents/data required for obtaining all statutory clearances and extend Technical assistance to Purchaser in getting the statutory clearances from statutory authorities like Directorate of Factories, Central Electricity Authority, Inspectorate of Explosives, Directorate General of Mines & Safety, Inspectorate of Boilers, etc., and to obtain licenses as required under Contract Labour act etc.

10.5.4 Submission of all stability certificates duly signed as required under the Factories Act, 1948 and amendments thereof etc. for the units engineered by the Contractor and ensure submission of the same to Purchaser/Consultant.

10.5.5 The detailed engineering shall be based on the basic engineering, soil investigations, geological data, survey data with regard to the steel plant site, and on any additional data furnished by Purchaser/Consultant or as may be given by Purchaser/Consultant in course of detailed engineering to the Contractor. Provision is to be made for the future expansion wherever feasible, in consultation with Purchaser/Consultant and the same is to be indicated in all the Layout drawings accordingly.

10.5.6 Prepare and submit total list of drawings for the units engineered and the date-wise submission schedule of drawings for Purchaser's approval.

10.5.7 All working drawings including those for foundation & civil engineering works shall be supplied in the sequence in which they are required for construction at site.

10.5.8 All erection drawings shall contain relevant safety instructions, "DO'S" and "DON'T'S" for erection, testing and commissioning.

10.5.9 The Contractor shall effect necessary modifications to any or all drawings issued by them as and when necessitated by site conditions and prepare supplementary details in consultation with Purchaser/Consultant so as to facilitate construction, fabrication & erection at site and submit the sketches/revisions made within three (3) days.

10.5.10 Engineering & issue of working drawings for modification of the existing units, if any, required for interfacing with the new units.



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10.5.11 On completion of each unit, the Contractor shall submit three (3) sets of soft copies on CD and one (1) plastic film along with six (6) prints of "Asbuilt" drawings in respect of all those drawings prepared in respect of all the units engineered by them and incorporating all the modifications authorized by the Purchaser/Consultant during the execution of the work. "As-built" drawings shall be submitted in stages after completion of individual units.

10.5.12 The drawings prepared by the Contractors shall be suitable for transmitting electronically and digitization for storage.

10.5.13 The Contractor shall follow the codification system, for all drawings and documents, made in consultation with Purchaser for indexing and storage in and easy retrieval from Technical Documentation & Information Section of Purchaser.

10.5.14 All correspondence, data, drawings, documents etc. shall be in English language and all technical data must be in SI units. 10.5.15 The contractor shall comply with the various schedules for supply of drawings, required feedback data, QAP, delivery of equipment, etc. till their obligations are fulfilled as per their respective contracts and agreements.

10.5.16 The contractor shall assist Purchaser/Consultant in technical matters arising out of the drawings / data / documentation supplied by them.

10.5.17 The Contractor shall ensure submission of final distribution copies in eleven (11) sets of prints, two (2) soft copies in CD and one (1) plastic film by them for all working drawings.

10.5.18 All fabrication & erection works must comply with latest national and international standard/practices pertaining to safety, health and environment.

10.5.19 The contractor shall ensure supply of all items like structural steel, sheeting and all consumables etc well in advance of the requirement, for the all structural works for the units engineered / supplied by them.

10.5.20 All the data / documents / test-certificates / external inspection reports etc., obtained from manufacturers/equipment suppliers at the time of inspection shall be handed over to Purchaser/Consultant along with the Inspection Certificate (IC) in the format mutually agreed to.

10.5.21 The Contractor shall ensure repair/replacement of inferior/sub-standard material received at site. All expenses for repair/replacement will be borne by the contractor.

10.5.22 The Contractor shall provide site supervision for the construction and erection activities for the project right from the start of site activities till completion of structural works. The scope of work under site supervision shall include and not limited to deployment of adequate number of experienced surveyors, graduate engineers, diploma holders, supervisors, skilled technicians and such other technical / nontechnical staff as may be necessary for supervising the site activities so as to ensure full compliance with the proposed plant layouts / drawings / specifications / standards and work practices and to maintain the quality of work and to ensure completion within the schedule.

10.5.23 The Contractor shall ensure workers wearing safety appliances during work.



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10.5.24 Tools & tackles used by contractors in erection are tested / certified by statutory authorities.

10.5.25 The Contractor shall ensure regular cleaning of various work sites at every stage of construction by contractors.

10.5.26 The Contractor shall ensure maintenance of daily record of manpower deployed in all the units by the contractor.

10.5.27 The Contractor shall ensure compliance with all statutory laws of the land viz., payment of minimum wages/PF remittances/labour license/insurance including third party/ Workmen Compensation Act etc. by the contractor.

10.5.28 The consultant shall ensure arrangement of adequate number of all the required instruments e.g. Electrometer, weld gauges, binoculars, vernier calipers, micrometer screw gauges etc., for their supervisory personnel for quality assurance of site work.

10.5.29 Engineers and Supervisory personnel must be deployed round the clock. In case of emergency jobs, mobilization of additional personnel/equipment must be done as per requirement even at short notices.

10.5.30 Computerized bill format shall be introduced to avoid human error in arithmetical calculation and to ensure necessary checking.

10.5.31 The contractor shall ensure that the bills raised are linked with the progress of work.

10.5.32 The Contractor shall arrange for experienced teams of personnel with all necessary survey equipment for ensuring the lines and levels at different stages of the construction activities, setting out schemes, pre and post construction / erection survey schemes for all the construction/ erection activities of the entire scope of work to avoid any inter-discipline mismatch and to achieve the accuracy as per drawings and good engineering practice.

10.5.33 The Contractor shall ensure overall quality of work by taking samples of all consumables such as bolts & nuts, electrodes, paints, sheets, construction materials, NDT of weld joints etc., and obtaining the test results from Quality Assurance & Technology Development (QA&TD) department of Purchaser or any other standard laboratory as specified in the contracts. All such activities shall be formulated and scheduled with the prior approval of the authorized representative of Purchaser from the concerned unit. The cost of the same shall be within the quoted price.

10.5.34 The Contractor shall be responsible for ensuring the safety of all the contract workmen and supervisory personnel deployed at all construction sites of the project and shall ensure compliance with all the relevant laws of the land, viz. Factories Act, IE Rules, labour license etc. and shall sign all documents required to ensure compliance with statutory obligations by Purchaser. All safety rules, fire protection procedures as prevailing in the plant as amended from time to time by the Purchaser shall also be complied with.

10.5.35 The contractor shall assist Purchaser/Consultant by participating in the discussions with statutory authorities etc., in case of accident at site.



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10.5.36 The contractor shall submit interim and final deviation statements, if any, of the works executed.

10.5.37 Submission of weekly, monthly and quarterly progress reports as per formats mutually agreed upon, indicating the progress of fabrication, erection, of the structures. The progress reports shall indicate the progress of item-wise manufacture / fabrication /erection/alignment/painting/punch list liquidation activities at site. The report shall indicate specific remedial actions to be taken to maintain the project on schedule.

10.5.38 The Contractor shall be responsible for ensuring the safety of all their workmen and supervisory personnel deployed at all construction sites of the project and shall ensure compliance with all the relevant laws of the land, viz. Factories Act, PF Act, IE Rules, labour license, etc., and shall sign all documents required to ensure compliance with statutory obligations by Purchaser.

10.5.39 The Contractor shall insure at their own cost the lives of all their workmen and staff deployed at Purchaser's site against accidents, sickness, and / or deaths and under no circumstance Purchaser/Consultant shall be liable to pay any compensation whatsoever on account of injury / disablement / sickness or death caused to the Contractor's employees, as the case may be and if any compensation becomes payable by Purchaser/Consultant on this behalf, then the same shall be recovered by Purchaser/Consultant from the bills of the Contractor.

10.5.40 Contractor for his services either at the Plant or anywhere else is found to be unsatisfactory, then such an employee shall be replaced suitably within fifteen (15) days of such a request made by Purchaser/Consultant.

10.5.41 The Contractor shall be responsible for the entire construction / erection / testing and commissioning of all the units and for the safety, stability and serviceability of all the structures / equipment / plant / machinery under all operating conditions and under varying conditions of soil and weather conditions.

10.5.42 Should there be any deficiency in the quality or any operational deficiency affecting the performance of any unit in part or as an independent unit or when integrated with the other upstream & downstream units, the re-engineering for effecting the necessary revisions / rectifications shall be carried out by the Contractor without any additional remuneration so as to enable the unit / plant to operate at its designed capacity without any defects or constraints in its operating parameters. The cost towards any replacements / repairs / modifications, etc., shall, however, be borne by the contractor concerned which shall be decided on case-to-case basis and the decision of Purchaser/Consultant shall be final and binding on all the parties concerned.

10.5.43 All the clauses of this Technical Specification are binding for the Contractor unless any of them is explicitly superseded by the Contract Technical Specification (CTS). If any confusion arises regarding which clause is superseded and which is not, in this regard, Purchaser/Consultant's interpretation/ decision shall be final& binding.

10.6 EQUIPMENT



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10.6.1 All construction and equipment once brought by the Contractor within the Project Area, are not to be removed from there without the written authority from the purchaser.

10.7 DESPATCH OF FABRICATED MATERIALS

10.7.1 The Contractor is solely responsible for any loss or damage during transit to any of the fabricated members, and as such proper precautions shall be taken by him to guard against such mishaps.

10.8 SETTING OUT

10.8.1 The Contractor shall be responsible for checking the alignment and levels of foundations, correctness of foundation; centres of anchor bolts etc. well in advance of starting erection work and shall be responsible for any consequence for non-compliance thereof. Discrepancies, if any, shall immediately be brought to the notice of the Purchaser. Any mistake subsequently found in alignment and levels of the structural steelwork due to non-verification of foundation before erection shall be corrected by the Contractor at his own expense

10.8.2 One set of reference axes and one bench mark level will be furnished to the Contractor. These shall be used for setting out of structures. Maintenance of such bench mark level shall be the responsibility of the Contractor.

10.8.3 The Contractor at his own expenses shall provide measuring instruments for setting out, levelling and aligning steelwork. He shall provide one exclusive survey team for alignment of structural works.

10.9 STAGING

Any staging necessary for the pre-assembly work of structures shall be provided by the Contractor at his own expense.

10.10 RULES & REGULATIONS OF SAFETY, ELECTRICITY BOARDS, FACTORY ETC.

The Contractor shall at all-time comply with all relevant factory acts, electricity rules, and safety regulations etc. as per statutory regulations of Central / State Government.

10.11 DEVIATIONS

Should the Contractor wish to deviate from any specification or details shown on the purchaser's approved drawings and / or Technical Specifications, he shall obtain the purchaser's written authority before proceeding with the deviations.

10.12 BASIS OF PAYMENT

The basis of payment shall be as per commercial terms of the Contract.

10.13 EXTRA ITEMS

Works which are not included in the schedule of items but which are required to be carried out for completion of the project, shall be carried out as per specifications, drawings, and /or sketches to be issued by the Purchaser. The payment for such items shall be based on rates to



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be derived wherever possible from available agreed rates. If such derivation of rates is not possible, the rates for such items shall be derived on the basis of actual cost of materials, labour and transportation, which shall be substantiated with relevant documents and records by the Contractor and verified by the Purchaser or his authorized representatives. An overall margin of 15 % towards cost of overhead and profit will be allowed.

10.14 MEASUREMENTS

10.14.1 STRUCTURAL STEEL

Structural steelwork will be measured by the metric tonne and as per IS: 1200 (part-8) - 1993 and IS: 1200 (part-9)-1973 subject to provisions outlined below:-

a) The calculation of quantities shall be based on unit-weights for structural sections as given in IS: 808-1989. In the case of mild steel/SAIL-MA Steel plates, the calculated weights shall be based on 78.5 kg per square meter per centimeter thick plate. The payments will be made on the basis of weights of members given in the approved fabrication drawings. However, any changes on the above weights during fabrication erection, payment shall be based on sketches Approved by the purchaser.

b) In the event the I.S. does not specify any mode of measurement for a particular item of work, the same shall be measured as per any other relevant international standard or as directed by the Purchaser.

c) The weight of all plates and sections shall be calculated from the approved drawing using the minimum overall square or rectangular dimensions and theoretical weight, no deduction being made for skew cuts, holes etc. In the case of plates, other than gussets, the actual dimensions shown on approved drawings will apply unless approved otherwise by the purchaser based on cutting diagram of mother plates.

d) The weight of all welding runs, bolt, stanchion base packing, cuttings to waste and rolling margins, and coatings of paint, will be excluded from the measured weight and shall be deemed to have been allowed for in the rates for structural steelworks quoted by the Contractor.

e) Temporary works and all other materials not included in the permanent works shall be excluded from any measurement for payment.

10.14.2 CLADDING SHEETS

a) Sheetting for roof slopes, louvers of big size and side cladding shall be measured by the square meter of net laid area, as specified and shown on the drawings.

b) No allowance shall be made for wastage, cut-outs, overlaps etc. in the measurement.

c) The unit of measurement shall include all fasteners, flashings and fittings such as ridges, corners, aprons and other accessories.

d) No deductions shall be made for openings for area less than a single sheet. Also no extra payment will be made for making opening and installing ventilation chimneys on roof.

10.15 PRELIMINARY ACCEPTANCE



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After completing the erection of a unit or portion thereof, the Contractor shall give a notice in writing stating that the job is complete in all respects and ready for preliminary acceptance. The job shall be jointly inspected visually by representatives of Contractor and Purchaser. All observed defects and omissions as per drawing and specification shall be noted down. If the defects are not major in the opinion of the purchaser/Purchaser's representative, the Contractor will be issued a preliminary acceptance certificate mentioning the defects, deficiencies and omissions which shall be made good by the Contractor within a period of 4 weeks.

10.16 FINAL ACCEPTANCE

10.16.1 Before commencement of inspection for final acceptance of the building or unit, the Contractor shall make available two complete sets of all drawings, representing "AS BUILT" drawing, (i.e. all additions and alterations done during fabrication and erection shall be incorporated in the drawings.

10.16.2 The Contractor shall make good all defects deficiencies and omissions noted down during preliminary acceptance and shall inform in advance the Purchaser/ his representative for conducting inspection for final acceptance. Final acceptance certificate will be issued by the Purchaser / his representative only after all defects / deficiencies / omissions noted under Preliminary Acceptance have been rectified.

10.17 MAINTENANCE & GUARANTEE

Commencing from the date of issue of final acceptance certificate or conclusion of Final acceptance tests, the Contractor shall stand guarantee for a period of 12 calendar months, for the satisfactory performance of steel structures of the unit. In the event of issue of more than one certificate by the Purchaser, maintenance period shall commence from the date of issue of last certificate for the particular unit. The Contractor shall replace/rectify all parts/components which become defective due to poor quality of material, bad fabrication or erection or due to any act of oversight or omission. Any leakage noticed in roof or side sheeting during this period shall be rectified or affected sheets shall be replaced. All such rectification or replacements of defective materials or workmanship shall be done free of cost by the Contractor.

ANNEXURE - A: PERMISSIBLE DEVIATIONS IN PITCH AND GAUGE OF HOLES FOR BOLTS AND RIVETS OF NORMAL ACCURACY (HIGH STRENGTH BOLTS INCLUDED)

Description	Hole diameter (mm)	Permissible deviations in spacing (mm)	Permissible deviations in each group of holes	Low Alloyed Steel	
			Mild Steel	Rivets	Bolts
Deviation in the hole diameter	Upto 17 Above	+1 +1.5	No limits		



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	17				
Ovality (difference between the biggest and the smallest dia)	Upto 17 Above 17	+1 +1.5	No limits		
Curves, exceeding 1 mm and cracks on the hole edges			Not Permissible		
Non-coincidence of holes in separate details of the assembled unit, • upto 1mm • 1-1.5 mm			Upto 50% Upto 10%	Upto 10% Not Permissible	Upto 50% Upto 10%
Slope of axis			No limits	Upto 20%	No limits

* Upto 3% of the thk. of unit but not exceeding 2mm in case of automatic and 3mm in case of manual pneumatic riveting. Anything exceeding the above mentioned figures is not permissible.

ANNEXURE –B: TOLERANCE OF ASSEMBLED COMPONENTS OF STRUCTURES

Description of Components of Structures	Deviation(±) in mm for the Elements of Structures (Length in Metres)						
	<1	1-5	5-10	10-15	15-20	20-25	>25
Deviations from the dimensions assembled. Length & width of the Details Cut :							
• Manual gas Cutting as per marking	3	3.5	4	4.5	5	-	-
• With shears or with a saw as per marking	2	2.5	3	3.5	4	-	-
• With shears or saw with a stop	1.5	2	2.5	3	3.5	-	-
• Machine Gas Cutting	2	2.5	3	3.5	4	-	-
Length and width of planed ends processed on Edge Planning Machine	1	1.5	2	2.5	3	-	-
Distance between the Centres of the End holes							
• Drilled according to marking	2	2.5	3	3.5	4	-	-
• Drilled according to a gauge with	1	1.5	2	2.5	3	-	-



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bushing							
Distance between the centres of Adjacent holes							
• Drilled according to marking	1.5	-	-	-	-	-	-
• Drilled according to a gauge with bushing	0.5	-	-	-	-	-	-
Deviation in the dimensions of despatch elements after completion of fabrication, Assembled in positioners or in other devices with clamps in fixed positioners and also							
• According to guide blocks with pins	2	3	5	7	8	9	10
• Assembled with bolts	3	5	8	11	12	14	15
• Size (length & width) between Milled surface (for all cases of assembly)							
• The same made in separate details during machining & fixed during the assembling work with clamps	1	1.5	2	2.5	3	3.5	4
• The same drilled according to positioners in finished structures	2	3	5	7	8	9	10
	1	1.5	2	2.5	3	3.5	4

ANNEXURE –C: EXTENT OF PERMISSIBLE DEVIATIONS IN ASSEMBLY OF WELDED JOINTS

S. No.	Description	Permissible Deviation	Diagram
1	Square Butt Joints <ul style="list-style-type: none"> Gap between the ends of plates (d) Stepping of one plate over the other (s) 	± 1 mm 1.0 mm	
2	Single V-groove Joints <ul style="list-style-type: none"> Bevel angle (A) Gap betn. Two (d) Stepping of one plate over the other (s) Root thickness 	$\pm 5^\circ$ ± 1.00 mm 2.00 mm 1.00 mm	



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3	Double V-groove Joints <ul style="list-style-type: none"> • Bevel angle (A) • Gap betn. Two (d) • Stepping of one plate over the other (s) • Root thickness 	$\pm 5^\circ$ $\pm 1.00 \text{ mm}$ 2.00 mm 1.00 mm	
4	Lap Joints <ul style="list-style-type: none"> • Overlap (B) • Gap between the surfaces (e) 	5.00 mm 1.00 mm	
5	Tee Fillet Joints <ul style="list-style-type: none"> • Gap between the edge of the web and the surface of the flange (e) 	2.00 mm	

ANNEXURE – D: TOLERANCES IN ERECTED STEEL STRUCTURES

A. COLUMNS

S. No	Description	Tolerance (mm)
1.	Deviation of column axes at foundation top level with respect to true axes in Longitudinal / Lateral direction.	± 5
2.	Deviation in the level of bearing surface of columns at foundation top with respect to true level	± 5
3.	Out of plumbness (vert.) of column axis from true vertical axis and measured at column top : a) For columns without any special requirements : • Upto and including 30m • Over 30 m height b) For column with special requirements like cranes or such similar requirements : • Upto and including 30m • Over 30 m height	$\pm H/1000$ subjected to $\pm 25\text{mm}$ maximum $\pm H/1200$ subjected to $\pm 35\text{mm}$ maximum $\pm H/1000$ subjected to $\pm 20\text{mm}$ maximum $\pm H/1200$ subjected to $\pm 35\text{mm}$ maximum
4.	Deviation in straightness in longitudinal & transverse planes of columns, at any point along the height.	$\pm H/1000$ subjected to $\pm 10\text{mm}$ maximum
5.	Difference in the erected position of adjacent pairs	± 5



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	of columns along length or across width of building, prior to connecting trusses / beams, with respect to true distance.	
6.	Deviation in any bearing or seating level with respect to true level.	± 5
7.	Difference in bearing levels of a member on adjacent pair of columns both across and along the building, from the true difference.	
NOTES: Tolerance specified under 3(a) and 3(b) should be read in conjunction with 4 and 5. "H" above is the column height in mm.		

B. TRUSSES

S. No	Description	Tolerance (mm)
1.	Shift, at the centre of top chord member of truss with respect to the centre of span or vertical plane passing through the centre of bottom chord.	$\pm 1/250$ of height of truss in mm at centre of span subjected to ± 15 mm maximum.
2.	Lateral shift of top chord of truss at the centre of span from the vertical plane passing through the centre of supports of the truss	$\pm 1/1500$ of span of truss in mm subjected to ± 10 mm maximum.
3.	Lateral shift in location of truss from its true vertical position.	± 10
4.	Lateral shift in location of purlins from true position	± 5
5.	Deviation in difference of bearing levels of trusses or beam from the true difference.	$\pm L/1200$ subjected to ± 20 mm maximum. (where L=span)

1. The tolerances specified do not apply to steel structures where deviations from true positions are intimately linked with or directly influence the technological process. In such cases, the tolerances on erected steel structures shall be as per recommendations of process technologists / equipment suppliers.

2. The observed or calculated values of deviations of steel structures from their true positions shall be rounded off in accordance with IS: 2-1960 for comparison with permissible tolerances specified in this table. The number of significant places retained in the rounded off value should be same as that specified in this table.

3. For all other cases, not mentioned above, IS: 12843 shall be followed for erection tolerances.



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ANNEXURE – E: MATERIAL OF CONSTRUCTION (AS APPLICABLE)

1. Unless otherwise specified in the drawing:

(a) All rolled sections and plates up to 20 mm thick shall conform to Grade- E250 or Higher & quality A of IS:2062 - 2011 and shall generally be of tested quality(semi-killed).

(b) Plates beyond 20 mm thick and up to 40 mm thick subjected to dynamic loading shall conform to Grade-E 250 or Higher & quality B as per IS:2062 - 2011. (rolled in killed condition)

(c) Plates beyond 40mm shall conform to Grade-E 250 or higher & quality B as per IS: 2062-2011 in normalized and ultrasonically tested quality.

(d) High strength micro-alloyed steel shall conform to SAIL-MA 350 HYA/HYB (SAIL product).

2. Zincalume high tensile steel sheet shall be of 0.5mm thick (TCT) and shall have trapezoidal profile with a cover width of 930-1020mm and 28-32mm deep crest at 186-250 c/c with minimum two ribs at centre for stiffening. The sheet shall be made out of steel of minimum $f_y = 550\text{MPa}$ conforming to AS 1397: 1993. The sheet shall be coated with hot dip metallic zinc aluminium alloy @ 150gsm coating mass total on both sides as per AS 1397: 1993. The colour coating shall be of super polyester XRW /SMP as per AS/NZS 2728: 1997 Category 3 of approved colour. The zincalume sheet shall have min. 5μ thick primer coat on both sides of the sheet over which shall be applied min. 20μ exterior coat on top surface and min. 5μ reverse coat on inner face. The end rib shall have anti-capillary groove to avoid any seepage of water through the lateral overlap.

(Roof and Side sheet shall be laid in colours as approved by Consultant / Client)

3. Chequered plates shall conform to IS: 3502-1994.

4. All gratings shall be galvanized (refer relevant chapter under Fabrication of TS)

5. The type of grating selected shall be based on the loading, for the area in which the grating is provided and shall be subject to approval of purchaser.



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6. Steel tubes for structural purposes shall be of medium thickness conforming to IS: 1161-2014 Grade YST-240 or higher).

7. All permanent bolts shall be of Grade B (semi precision) conforming to IS: 1364(Part 2)-2002. Material of bolts shall be of Class 4.6 or higher as per requirement and conforming to IS: 1367 unless noted otherwise. Hexagonal nuts for permanent bolts shall conform to IS: 1364(Part3) – 1983. High strength bolts shall confirm to class 10.6 / 8.8. / 6.8 as specified in drawings.

8. All erection bolts shall be black hexagonal bolt of Grade C conforming to IS: 1363(Part 1)-2002. Material of bolts shall be of Class 4.6 and conforming to IS: 1367 unless noted otherwise. Hexagonal nuts for erection bolts shall conform to IS: 1363(Part 3)-2002.

9. All washers shall conform to IS: 6610-1972.

10. All High Strength bolts shall conform to IS: 3757-1985. Nuts for these bolts shall be of high strength conforming to IS: 6623-2004 and hardened steel washers to IS: 6649.

11. All paint materials shall be conforming to Indian Standards and of approved make. For the paints where IS code doesn't exist, the manufacturer shall submit complete information of paint in the form of a catalogue and manufacturer's test certificate. The same shall specify quality of matching thinner, covering capacity, DFT etc. The make of the paint shall be approved by purchaser / consultant.

12. Covered electrodes for arc welding shall conform to IS: 814 - 2004 Electrode to be used for submerged arc welding shall confirm to specification IS: 7280-1974. Coding of electrodes shall be as follows:-

a) ER 421 'C' x for mild steel of Grade E250 quality A and B as per IS:2062-2006.

b) EB 542 'C' x H3X for

i) Mild Steel of Grade E250 quality B as per IS:2062-2006 for dynamically loaded structures (arising out of crane, vibratory screen, equipment etc.)

ii) For SAIL-MA micro alloyed steel 350 HYA/HYB.

i) When combined thickness (CT) for steel conforming to IS: 2062-2006 exceeds 40mm as per Fig.1 below.



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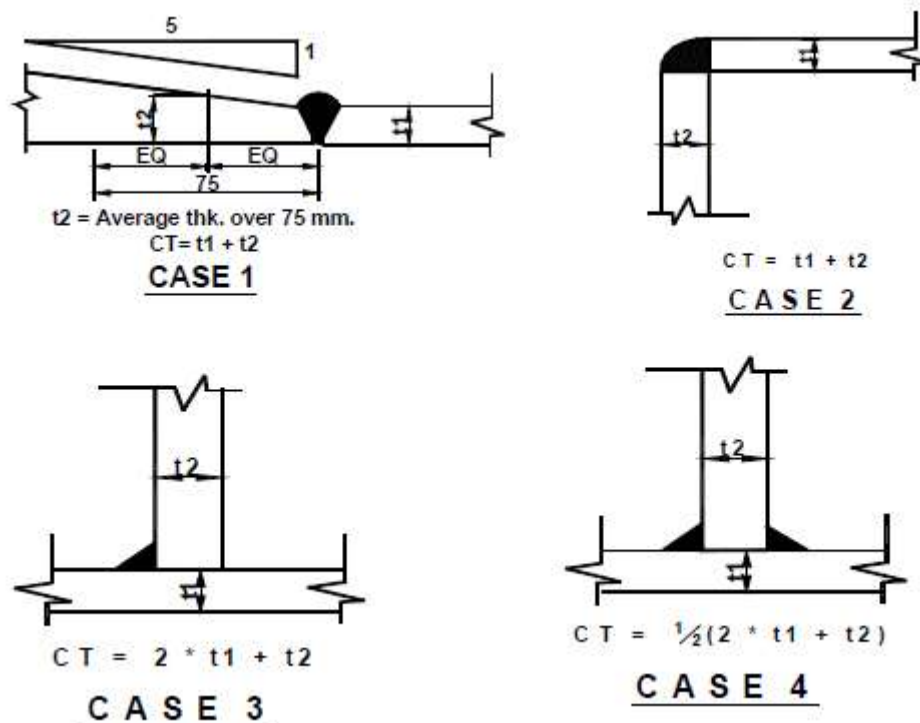


Fig. 1 – For Calculation of Combined Thickness (CT)

Where "C" in the electrode specification, is the designating digit for welding current & voltage conditions, as recommended by the electrode manufacturer.

Alternatively,

Electrodes may also confirm to AWS specifications and shall be as follows.

- E6013 for all fillet welds of IS2062 steel, Gr E250 quality A & B
- E 7018 for all fillet welds of SAIL-MA 350 HYA Steel
- E7018 for all butt welds including site welds irrespective of quality of steel viz IS 2062 gr E250, quality A, B or SAILMA 350 HYA steel

However, electrodes, after their date of expiry or older than six months from date of manufacture, shall not be used.

13. The MS / GI gratings shall be electro-forged and shall be of approved brand and manufacturer unless otherwise agreed by the purchaser. The type of grating selected shall be based on the loading area in which the grating is provided and shall be subject to approval of purchaser.

14. Preferred / Approved makes for the materials shall be as indicated in Annexure-F.



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Annexure-F: Preferred / Approved Makes

Sl. No.	Material Description	Manufacturers/Suppliers
1	Structural Steel	SAIL / RINL / IISCO / TATA / ESSAR / JINDAL / ISPAT
2	Welding Electrodes for structural steel	GEE, D&H (India), ADOR, D&H (Secheron), ESAB
3	Structural Steel Tubes ISI Marked	TATA / JINDAL / SURYA / SWASTIK
4	Pre-color coated Galvalume Sheets	Tata BlueScope, Lloyds Insulations(India), JSW Steel Ltd., Everest
5	Paints	Akzo-Nobel, Asian Paint, Kansai Nerolac Paint, Berger Paints

In case of some items not covered in this list like fasteners, fixtures etc. may be procured from the market conforming to relevant IS codes with test certificates, with prior approval from the Client / Consultant.



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