

ITP NO.: 2845

CABLE TERMINATION

Sl. No.	Activity	Contractor	EIL
1.	Ensure proper tagging of the cable at both ends.	WC	S
2.	Ensure cables are laid separately for HT & LT system as per spec.	WC	S
3.	Ensure cables are properly dressed, clamped & glanded using suitable sizes/ class of cable glands.	WC	S
4.	Ensure sufficient cable length is kept on both ends for future re-termination, if need arises.	WC	S
5.	Ensure proper bending radius while laying to avoid twisting.	WC	--
6.	Ensure cable segregation, spacing & depths maintained as per specifications	WC	S
7.	Ensure usage of correct sizes of lugs for termination	WC	S
8.	Ensure all cores are firmly terminated to terminals provided in individual feeders.	WC	S
9..	Ensure proper earthing of armour.	WC	S
10.	Ensure continuity & IR value checks are done on the cable from panels to equipments.	WC	W
11.	Ensure unused entries are plugged tightly in panels, motor terminal boxes, JB's, etc	WC	S
12.	Ensure on completion of cable termination, the cable trenches are backfilled & trench covers put back in position.	WC	S
13.	Ensure all cable openings & conduit entries are properly sealed.	WC	S
INSPECTION & TEST DOCUMENTS			
	Review Test and Inspection Documents	WC	Rw

Format No: **G: 0 1 REV 0**
INCOMING MATERIAL INSPECTION REPORT

Project : _____ Unit : _____
 Contractor : _____ Consultant : _____
 Work order No.: _____ P.O. No. & Date : _____

Report No. : _____
 Date : _____

Name of Work : _____
 Job No. : _____
 LR No. : _____

Sl. No.	SOR Item No.	Material Description/ Tag No.	Date of Receipt	Qty. Received	Qty. Accepted	Manufacturer/ Vendor	MTC No./ IRN No. with Date/ Field, Lab Test, etc.	Heat/ Batch No.	Ref. Invoice/ Challan No.	Observation/ Remarks/ Storage Instruction

Notes :
INSPECTION ACTIVITY AT SITE (Tick as applicable)

1. Quantity verified and found in order 2. Material condition appears to be good
 4. Color coding done as applicable 5. Site identification mark on material
 7. TC verification w.r.t. IRN/Spec/QAP, etc. 8. Check for Vendor/Source approval
 3. Heat/Batch/Tag No. mentioned on the material
 6. Correlation w.r.t. IRN/MTC/Lab Tests report
 9. Special Requirement if any.

Based on above, materials are accepted.

Contractor Field Engineer
 Name: _____

Contractor RCM / Site In-charge
 Name: _____

EIL Field Supervisor
 Name: _____

EIL Lead Engineer/ Area Coordinator/ Spread In-charge
 (Countersigned)
 Name: _____

1.0 SPECIFICATION FOR ERECTION OF EQUIPMENT AND MACHINERY

1.1 Scope

This specification covers technical requirements for erection of all static and rotating equipment by erection contractor at site. This specification is applicable for all the erection tenders operated by EIL.

1.2 General

1.2.1 All necessary handling equipments, tools, tackles and precision instruments for carrying out the works as specified shall be provided by the Erection Contractor (EC) at his cost. EC must provide all tools and gauges for erection and alignment. Special tools, if any, received as part of machinery, will be given to EC for erection purposes, which shall be returned in good condition after use. Suitable deductions will be made by the Engineer-in-Charge (EIC) in case of loss or damage of the special tools. The value of such loss or damage will be decided by the EIC and EC shall be bound by such a decision.

1.2.2 Equipment Manufacturer's recommendations regarding preservation during storage at site and detailed specifications for the installation alongwith layout drawings, general arrangement/equipment outline drawings and sub-assembly drawings of the various equipment and machinery will be provided to EC during the performance of work. The requirements stipulated in these shall be fulfilled by EC in addition to what is stated in this specification. Erection shall be carried out as per the instructions and supervision of Machinery manufacturer's representative, wherever such supervisory services are applicable.

1.2.3 All the items of work covered in the tender shall be carried out as per this Specification and other details to be furnished to EC. However, EIC reserves the right to give additional/alternative specifications and instructions, at any time, for execution of any particular work and EC shall execute such works in accordance with such additional/alternative specifications and instructions of the EIC. Such a step taken by the EIC shall not constitute a breach of the contract.

1.3 Preparation for Erection

1.3.1 EC shall be responsible for organising the lifting of the equipment in the proper sequence, so that orderly progress of the work is ensured and access routes for erecting the other equipment are kept open.

Rigging procedure for all the major lifts (above 10 MT) and at maximum crane capacity shall be submitted by EC for the approval of EIC. However, approval to rigging procedure proposed by EC shall not relieve EC from his responsibility in following the proper lifting/erection methods on ensuring orderly .

1.3.2 Orientation of all foundations, elevations, length and disposition of anchor bolts and diameter of holes in the supports saddles shall be checked by EC, well in advance. Minor rectifications including chipping of foundations as the case may be, shall be carried out by EC after obtaining prior approval of EIC. EC shall also be provided with the necessary structural drawings and piping layouts etc. wherever required for reference. EC shall crosscheck such piping and structural drawings with actual construction at site and in case of any mismatch inform the EIC before taking up the erection.

1.3.3 During the performance of the work, EC shall keep structures, materials or equipments adequately braced by guys, struts or otherwise approved means which shall be supplied and installed by EC as required till the installation work is satisfactorily completed. Such guys, shoring, bracing, strutting, planking supports etc. shall not interfere with the work of other agencies and shall not damage or cause distortion to other works executed by him or other agencies.

2.0 ERECTION OF COLUMNS, TANKS, VESSELS AND DRUMS ETC.

2.1 Scope of work of Erection Contractor

- (a) Preparation of erection scheme and rigging procedure and obtaining its approval from EIC wherever necessary.
- (b) Withdrawal of equipments from Owner's storage point, checking and reporting its conditions, transporting the same to EC's stores of work site including unloading etc.
- (c) Erection on foundations furnished by Owner including aligning, levelling and grouting.
- (d) Assembly and fixing of demisters, grids, internal distributors and other internal fittings in Columns, Vessels etc.
- (e) Filling of Columns, Reactors, Vessels/Drums etc. with Raschig rings, supporting elements, sand, concrete etc. as required.
- (f) Welding of washers for equipments, erection of pipe davit & minor welding of their parts as per specifications and instruction of EIC.
- (g) Assembly & erection of Agitator (Mixer) along with drive unit (Motor) including all accessories for vessels/drums/reactors (wherever indicated) as per specification drawings & instructions of EIC.
- (h) Flushing, cleaning and drying of Columns, Vessels/Drums etc.
- (i) Completing the equipments in all respects for commissioning the plant as per drawings, specifications & instructions of EIC.
- (j) Any modification in the erected Columns, Reactors, Vessels/Drums to the complete satisfaction of EIC.

2.2 General Conditions of Erection

2.2.1 Unless otherwise specified Columns, Vessels, Drums etc. will be generally supplied to the Erection Contractor in single piece and EC will not be required to carry out any assembly or welding. In case column is supplied in multiple pieces and erection of the equipment is not possible in single piece, EC shall be responsible for lifting the pieces, for aligning, welding and hydrotest etc. in vertical position under the supervision of column Supplier (Fabricator). However, EIC shall be responsible for coordination between Erection Contractor & Fabricator. The schedule of quantities (SOQ) for equipment erection enclosed with the tender document outlines details of each equipment such as diameter, overall height, type of support (saddle/skirt/leg/bracket), position (horizontal or vertical) and approximate erection weight etc. However the erection elevation and location of equipment shall be as per the piping layout drawing enclosed with the tender.

- 2.2.2 Rigging procedures and erection schemes for all the heavy lifts weighing 10 MT & above shall be prepared by EC and got approved by EIC. Approval by EIC shall not relieve EC of his responsibilities. The details to be submitted will include the location of equipment from where it will be lifted, location of crane(s), details of crane(s) (like configuration, boom length, operating radius, boom point elevation, clearance underside the boom and the equipment, lifting capacity, counter weights to be deployed, holds on any neighbouring foundations, structures, equipments etc.), the load chart of the crane(s), design of the lifting tackles like spreader beam, D-shackles, wire rope slings etc. Unless the erection scheme and rigging procedures are approved by EIC, erection of such equipments shall not be undertaken in any case by EC.
- 2.2.3 Before starting the erection of Columns, Vessels etc., top surface of the foundations is to be cleared/chipped, roughened to obtain proper bond, while grouting. Also the sleeves are to be cleaned before erecting the equipments. Line (orientation) and levels are to be marked on all the foundations to facilitate checking of alignment.
- EC shall also check the correct elevation and orientation of civil, structural foundations, before proceeding with the erection work. Discrepancy, if any, shall be brought to the notice of EIC. However, minor rectifications and chipping of foundations upto a thickness of 15 mm in foundation height shall be carried out at no extra cost, by the EC. EC shall be responsible for supply of levelling plates, (if required) and shall carry out levelling of equipment under the directions of EIC.
- 2.2.4 While handling, transporting or erecting the equipments, care shall be taken not to damage the nozzles, instrument connections, structural clips etc. EC shall also take care of the orientation of the nozzles and other connections of the equipments while erecting the same and ensure compliance with the drawings and specifications supplied. Discrepancy, if any, in the number/orientation of the nozzles, cleats etc. should be brought to the notice of the EIC before actual erection is started.
- 2.2.5 Verticality of the Columns, Reactors/Vessels shall be checked with theodolites. After erection the equipment shall be levelled and properly aligned with necessary shims and wedges supplied by EC, at his cost. After the level, alignment and verticality etc. are checked and approved by EIC, EC shall carry out grouting.
- 2.2.6 EC shall produce recent test certificates of the slings which they will be using for erection work. However, retesting of the slings shall be done at site by EC at his cost, as and when required by EIC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by EC at his cost. Tested slings will be punched for test loads and date of testing as directed by EIC.
- 2.2.7 EC shall also carry out the assembly, erection, levelling and alignment of all types of weir plates, baffles, distributors, collectors, spray nozzles, demisters, grids and other internal fittings etc. Work shall be carried out as per manufacturer's standards/specifications which shall be made available to EC at the time of erection. Raschig rings, molecular sieves, intalax saddles packing and other types of tower packings such as sand, catalyst etc. and SS wire mesh shall be loaded into sections of Vessels, Columns as per specifications and drawings. Details for internals to be installed by EC shall be as per separate schedule of quantities enclosed with the tender document. All packings except clay and lime stone shall be washed with water before filling. Bottom layers, if required, shall be arranged as directed and random filling shall be done afterwards with equipment filled with water. Installation of packings, shall be done only after flushing and cleaning of Columns/Vessels and completed to the satisfaction of EIC.

- 2.2.8 EC shall carry out minor welding for attachment of prefabricated pipe davit parts such as rain covers, handles etc. with pipe davit, during or after erection of the same as per the manufacturer's specifications, at no extra cost to the Owner.
- 2.2.9 EC shall execute erection of wooden pillow for saddle support for cold horizontal vessels wherever necessary as indicated on the drawings/ EIL STD 7-12-0003 and as per the instructions of EIC.
- 2.2.10 EC shall execute assembly & erection of agitator/mixer along with drive unit including all accessories as per supplier's instructions, specification drawings & instructions of EIC.
- 2.3 Flushing & Cleaning of Columns, Vessels, Drums etc.**
- 2.3.1 After the erection, alignment and grouting of these equipments are complete, flushing and cleaning shall be carried out by EC as per specifications and instructions of EIC.
- 2.3.2 After flushing, cleaning and draining, equipments shall be dried by compressed air at the pressure and for duration decided by the EIC. The Vessel interior shall be thoroughly inspected to the complete satisfaction of EIC before it is finally boxed up. Boxing up of manholes and handholes shall be leak proof. All joints which need remaking, shall be remade. Compressed air for drying shall be arranged by EC.
- 2.4 Inspection and Acceptance Limits for Level and Alignment**
- 2.4.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by EC.
- 2.4.2 Before equipments are placed on foundations, orientations shall be checked with respect to piping drawings.
- 2.4.3 When equipments are firmly bolted down but prior to grouting, verticality of all the Columns, vertical vessels etc. shall be checked by using theodolite. Tolerances for equipment after erection shall be as per EIL Standard 7-12-0001. The allowable deviation from plumb line shall be 1 mm per metre height, subject to maximum of 15 mm unless otherwise stated on the drawings.
- 2.4.4 Horizontal Vessels shall be checked for level across machined face of nozzle flanges with precision level.
- 2.5 Additional requirements for Underground buried vessels**
- 2.5.1 **Underground vessels for operating temp upto 60°C**
- The vessels shall be supplied at site with one coat of inorganic zinc silicate primer duly applied on its external surfaces as per Spec. 6-79-0020. All other works such as application of coal tar enamel, as per 6-79-0020 & wrapping and coating as per EIL Spec. 6-79-0011 shall be carried out by EC. This shall include necessary materials, tools and tackles to complete the Job in all respect as per the instructions of EIC.
- 2.5.2 **Underground Vessels for operating temp. Above 60°C and upto 300°C**
- The vessels shall be supplied at site with one coat of inorganic zinc silicate primer as per Spec. 6-79-0020 duly applied on its external surfaces. EC shall be required to carry out touch-up and repair of outside primer before erection of equipment.

2.5.3 EC shall do the necessary excavation, backfilling and removal of surplus earth at the site as per the directions of the EIC. EC's rate shall include the excavation, blast cleaning, painting, wrapping by kraft paper, placing and fixing of Vessels, backfilling and removal of excess earth.

3.0 ERECTION OF MECHANICAL EQUIPMENT

3.1 Scope of Work of Erection Contractor

The scope of EC shall consist of withdrawal and transportation of equipments and accessories from Owner's stores to site, assembly of loose supplied components/parts erection of equipment on foundations, levelling, aligning and grouting, preparation of equipments for trial runs and hand over in fit condition for the start up of the plant as per instructions of EIC.

3.2 Details of Owner Supplied Equipments

Equipments to be erected shall be supplied by the owner. Equipments may be supplied in any of the following conditions.

- Single equipment such as filter, static mixer, silencer etc.
- Skid mounted equipment, fully assembled.
- Skid mounted equipment with some items supplied loose or as subassemblies involving interconnections also.
- System comprising of many equipments, skids with interconnected piping & hook up.

3.3 Technical Requirements

- 3.3.1 All equipment/machinery erection shall be done by experienced fitters. For this purpose EC shall employ an experienced erection supervisor and crew who have done similar jobs.
- 3.3.2 EC shall study the layout drawings, for the machineries and equipments with their auxiliaries, controls defining scope of supply.
- 3.3.3 Equipments shall be checked for any damages as a result of transport, handling and defects, if any, shall be reported to the EIC. Rectification of defects shall be carried out in accordance with approved procedure.
- 3.3.4 Correct procedures for handling of equipment & installation on the foundation shall be followed as given in the manufacturer's manual. In case of non-availability of such procedures, EC shall develop & submit handling procedures for all equipment weighing more than 10 metric tonnes. The handling procedure shall be approved by the EIC.
- 3.3.5 EC shall check the correctness of equipment foundations or supporting structures as per the drawings. Equipment/Skid foot print dimensions shall be verified to match with the foundation. Minor chipping of foundation, pockets if required shall be carried out by EC.
- 3.3.6 All accessories like pressure gauges, seal oil, cooling water & Lube oil headers etc., shall be tagged and separately kept in Contractor's stores till erection. All flanged connections and openings shall be kept blanked with dummies, plugs to prevent entry of foreign particles.
- 3.3.7 Equipments shall be installed on the foundations in proper sequence. In case the equipments are delivered in subassemblies, EC shall do the assembly work as per manufacturer's instructions.
- 3.3.8 Equipments shall be installed in the correct orientation and alignment.

- 3.3.9 After installation and levelling the equipment shall be grouted with the specified grouting applied to the baseplate and support.
- 3.3.10 EC shall remove all the packing and protective devices used during transport and handling from the equipment such as shock absorbent materials from machined faces, blocking of shafts or rolling bearings & restraining devices from instruments, safety devices and protective equipments.
- 3.3.11 After the grouting is set & cured, the foundation bolts shall be checked to make sure that they are in straight and vertical position and properly tightened. Shims, if used, shall be on either side of the foundation bolts.
- 3.3.12 Desiccant, catalyst where supplied loose shall be loaded on to the respective vessels in specified quantities as per the suppliers instructions.
- 3.3.13 Internals, where supplied loose shall be assembled as per the drawings and manufacturer's instructions.
- 3.3.14 Unless otherwise specified, all the instruments such as pressure gauges, sight glasses temperature recorders etc. including instrument panels, if any, supplied along with the equipment with necessary connections, shall be installed by EC as part of Equipment erection.
- 3.3.15 Equipments shall be checked for final cleanliness before boxing up.
- 3.3.16 Any interconnected piping & ducting shall be properly installed and supported. EC shall connect the gas, steam, air, utility piping, instruments, oil piping etc. as per manufacturer's drawings, specifications and instructions of the EIC.
- 3.3.17 Safety devices shall be correctly installed.
- 3.3.18 Ladders, platforms, walkways shall be correctly installed with handrails, and flooring shall be properly secured.
- 3.3.19 Field welding, where specified shall be in accordance with the specified procedures and NDT tests where specified shall be carried out. Results of NDT tests shall be recorded.
- 3.3.20 Equipment alignment & couplings shall comply with tolerances specified in manufacturer's drawings and manuals. Provisions of dowel pins or similar arrangements for retaining the alignment shall be carried out.
- 3.3.21 After the piping has been connected, the alignment shall be checked by EC again, to ensure that piping connections do not induce any undue stresses on the Equipments. After making necessary corrections on the piping, if any, realignment shall be done by EC to ensure that no undue stresses are induced on the equipment.
- 3.3.22 Painting, insulation & fireproofing where specified shall be carried out in accordance with the applicable specifications attached in the tender document.
- 3.3.23 Any alterations, deviations made during equipment erection with respect to manufacturer's drawings or instructions shall be duly recorded and approval shall be taken from the EIC.
- 3.3.24 Any special tools, tackles supplied along with the equipment and used during installation shall be returned to the stores through the EIC.
- 3.3.25 Any protection of the equipment after installation, if required shall be carried out in accordance of the instructions of the EIC.

3.4 Trial Runs

- 3.4.1 Wherever specified, Machinery & Equipment erected & installed by EC under the supervision of Machinery/Equipment supplier shall be subjected to trial runs in accordance with clause 5.4 of this specification. Job specific trial run procedure, if specified, supersedes the trial run procedure as described in clause 5.4.

3.5 System Start-up

During this phase of work, EC shall provide as part of his work necessary skilled personnel as per requirement of EIC. Any defects noticed in the Equipment shall be made good by EC at his cost if such defects are attributable to him.

4.0 HEAT AND MASS TRANSFER EQUIPMENT

This section covers the minimum requirements for erection of the following equipment by the EC.

- Deaerator
- Trays/tower Internals And Tower Packings
- Separators And Internals
- Shell And Tube Heat Exchangers
- Double Pipe Exchangers
- Electric Heaters
- Plate Exchangers
- Plate Fin Exchangers
- Sulphur Recovery Unit Equipment like Combustion Chambers, Waste Heat Boilers, Sulphur Condensers, Incinerators, Burners, Etc.
- Waste Heat Recovery Units
- Desalters
- Vacuum Ejectors
- Ejector Condensers

4.1 Scope of Work of Erection Contractor

- 4.1.1 Preparation of erection scheme and rigging procedure and obtaining its approval from EIC wherever necessary.
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- 4.1.2 Withdrawal of equipment from Owner's storage point, checking and reporting its conditions, transporting the same to EC's stores and work site including unloading etc.
- 4.1.3 Preparation of foundation by chipping & installation of base plates for foundations. Minor rectifications & chipping of foundations up to a thickness of 15 mm due to error in foundation height, shall be carried out by the EC at no extra cost
- 4.1.4 Before starting the erection, top surface of the foundations are to be cleaned/chipped/roughened to obtain proper bond while grouting. Line (Orientation) & Levels are also to be marked on the respective foundations prior to erection to facilitate checking of alignment.
- 4.1.5 Supply of necessary shims, levelling plates, wedges, sliding base plate.
- 4.1.6 Erection on foundations furnished by Owner including aligning, levelling and grouting.

- 4.1.7 Assembly and fixing of trays, tower internals (distributor, bed limiter, support plate, chimney trays, vapour distributor etc.), demisters, grids, internal distributors and other internal fittings in columns, vessels etc.
- 4.1.8 Installation of transformers on desalters and their electrical connection to electrode grid etc.
- 4.1.9 Welding of chimney trays, lattice girders, beams etc. wherever required.
- 4.1.10 Carrying out minor adjustments, modifications, seal welding of seal plates etc. wherever necessary during installation.
- 4.1.11 Checking of installed trays & tower internals and filling of installation formats as referred in 6-14-0016.
- 4.1.12 Filling of columns, vessels/drums etc. with Raschig rings/Pall rings/ Structured packing, as required.
- 4.1.13 Welding of washers for equipment, erection of pipe davit & minor welding of their parts as per specifications and instruction of EIC.
- 4.1.14 Hydrotesting of shell and tube heat exchangers if the time gap between last hydrotest is more than six months or in case it is found to be necessary by EIC. Procedure is given in para 4.3 & 4.4 below. EC to note that any equipment which are refractory lined at shop shall not be hydrotested.
- 4.1.15 Flushing, cleaning and drying of equipment using compressed air and blinding to prevent ingress of rain, dust etc.
- 4.1.16 Installation of refractory lining, brick lining, ceramic boards etc., as per specifications, recommendations of manufacturer and instructions of EIC.
- 4.1.17 Mounting of instruments like safety valves, rupture disks, sight glasses etc as required.
- 4.1.18 Completing the equipment in all respects for the commissioning of the plant as per drawings, specifications & instructions of EIC.
- 4.1.19 Any modification in the equipment to the complete satisfaction of EIC.
- 4.1.20 In addition to the above EC may be called upon to do other jobs like rectification of defects etc. as per instructions of EIC.
- 4.2 General Conditions of Erection**
- 4.2.1 All carbon steel components of trays/tower internals shall be cleaned to remove rust preventive coating.
- 4.2.2 All welding shall be done by qualified welders only. The electrodes/filler material to be used shall be compatible with the metallurgy of component and shall be used only after prior approval of EIC.
- 4.2.3 A proposed Welding Procedure Specification (WPS) shall be submitted to EIL/ Owner's Inspector for his approval. On approval, a Procedure Qualification Test (PQT) shall be conducted which shall be witnessed by EIL/Owner's Inspector. On acceptance of all tests as per ASME Section IX, a final WPS along with Procedure Qualification Record (PQR) shall be submitted. Production welding shall start only after approval of final WPS/PQR and

qualification of welders as per ASME Section IX. EIL/Owner's Inspector may accept previously qualified WPS/PQR at his sole discretion.

- 4.2.4 Lattice girders wherever provided for supporting tray & tower internals have been designed in such a way that various components pass through column manway. Components/parts of lattice girders are to be welded inside the column as per respective drawings. EC shall also ensure that all parts of lattice girder are properly welded & levelness of the lattice girder shall be checked before & after the welding. The limits of levelness as mentioned in GA drawings shall be adhered to.
- 4.2.5 The rigging procedure shall include the following as a minimum:
- Location of equipment from where it will be lifted, location of crane(s), details of crane(s) (like configuration, boom length, operating radius, boom point elevation, clearance underside the boom and the equipment, lifting capacity, counter weights to be deployed, holds on any neighbouring foundations, structures, equipment etc.), the load chart of the crane(s), design of the lifting tackles like spreader beam, D-shackles, wire rope slings etc. Unless the erection scheme and rigging procedures are approved by the EIC, erection of equipment shall not be undertaken in any case by the EC.
- 4.2.6 While handling, transporting or erecting the equipment, care shall be taken not to damage the nozzles, instrument connections, structural clips, refractory lining etc. EC shall also take care of the orientation of the nozzles and other connections of the equipment while erecting the same and ensure compliance with the drawings and specifications supplied. Discrepancy, if any, in the number/orientation of the nozzles, cleats etc. should be brought to the notice of the EIC before actual erection is started.
- 4.2.7 After erection, the equipment shall be levelled and properly aligned with necessary shims and wedges supplied by EC, at his cost. After the level, alignment and verticality etc. are checked and approved by EIC, EC shall carry out grouting.
- 4.2.8 EC shall produce recent test certificates of the slings which they will be using for erection work. However, retesting of the slings shall be done at site by the EC at his cost, as and when required by the EIC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by EC at his cost. Tested slings will be punched for test loads and date of testing as directed by EIC.
- 4.2.9 EC shall also carry out the assembly, erection, levelling and alignment of all types of weir plates, baffles, distributors, collectors, spray nozzles, demisters, grids and other internal fittings etc. Work shall be carried out as per manufacturer's standards/specifications which shall be made available to EC at the time of erection. Raschig rings/Pall rings/Structured packing, molecular sieves, intalox saddles packing and other types of tower packing such as sand, catalyst etc. and SS wire mesh shall be loaded into sections of vessels, columns as per specifications and drawings. Details for internals to be installed by EC shall be as per separate schedule of quantities enclosed with the tender document. All packing except clay and lime stone shall be washed with water before filling. Bottom layers, if required, shall be arranged as directed and random filling shall be done afterwards with equipment filled with water. Installation of packing, shall be done only after flushing and cleaning of columns/vessels and completed to the satisfaction of EIC.
- 4.2.10 EC shall carry out minor welding for attachment of prefabricated pipe davit parts such as rain covers, handles etc. with pipe davit, during or after erection of the same as per the manufacturer's specifications, at no extra cost to the Owner.
- 4.2.11 EC shall install base plate over the sliding end foundation before erection of shell and tube exchangers.

- 4.2.12 Levelling and plumbness shall be approved by EIC and shall be checked using theodolite before grouting and final finishing of the foundations. The record of the same shall be maintained.
- 4.2.13 EC to ensure that shell and tube exchangers shall be firmly bolted down to foundations at the fixed end. Further EC to ensure that foundation bolts at the sliding saddle end are at the centre of slotted holes & nuts at sliding end are only hand tightened. Projected bolt threads shall be properly protected by application of grease etc. to avoid rusting and for facilitating free movement of nuts.
- 4.2.14 EC shall ensure that no equipment is subjected to any corrosion during any stage during his period of work till handing over to EIC/Client.
- 4.2.15 Instruments, as required, shall be mounted by EC. On instructions of EIC, EC shall also remove and hand over the instruments to EIC for calibrations. During this period, EC shall cover all openings to protect the equipment.
- 4.2.16 Before transportation to site, EC shall check and report to EIC on the condition of equipment, specifically highlighting the nitrogen pressure indicated in the nitrogen gauges and the absence of blinds on any of the nozzles.
- 4.2.17 In case the shell and tube exchangers are to be stacked, but have been stored as single shells at the store, then EC shall erect the bottom most shell, then erect other shell(s) sequentially using the nozzle gaskets/bolting and saddle bolting supplied by owner. Additional shims, if necessary, shall be supplied by EC. If the exchangers do not have interconnecting nozzles, then nozzle elevations shall be maintained as per piping GAD.
- 4.2.18 All equipment, consumable and other accessories required for completion of the job shall be arranged by the EC. This would include but not limited to cranes, tools and tackles, manpower etc; machinery for cutting, grinding, drilling etc. of base plates; instruments like dumpy level, plumb lines, Engineer's levels, precision levels, theodolite, straight edges etc. for checking the alignment/erection accuracy, hydrostatic testing pumps, potable water for hydrotesting, necessary materials including making the arrangements for hydro-testing, hoses, compressed air supply, pressure gauge, sealing taps, blinds, shims and wedges for alignment etc.
- 4.2.19 EC shall execute the erection of wooden pillows for saddle supports for cold equipment as indicated in schedule of quantities, EIL standard 7-12-002 and instructions of EIC.
- 4.2.20 For bought out items like plate exchangers, plate fin exchangers, electric heater, etc. vendor's instructions shall be followed.
- 4.2.21 For erection of piping of ejector system, EC shall follow relevant erection specification of piping for the project.
- 4.2.22 EC shall check the health of the equipment refractory lined at shop on receipt and shall report any defect or damage in the same to EIC. During installation all precautions shall be taken to avoid any damage to refractory lining. Any damage to refractory during erection shall be repaired by EC at his own cost without loss of time.
- 4.2.23 Wherever equipment with refractory are bolted or welded at the girth joints, the gaps between the refractory shall be suitably filled with ceramic fiber of suitable grade as given in the drawings or other relevant documents of the equipment.
- 4.2.24 Refer section 1.0 (General) for additional requirements.

4.3 Hydrotesting of Shell and Tube Exchangers including Condensers

- 4.3.1 These shall be hydrotested at site using potable water. Hydrotesting of both shell and tube sides shall be carried out as per procedure given below or as per instructions of EIC. For exchangers fitted with SS bellow or SS part, potable water with max. 25 ppm chlorides shall be used for hydrotesting.
- 4.3.2 Suitable pump set, piping, test pressure gauges and other instruments, water-hoses, temporary gaskets, metallic blinds, bolts, nuts, consumable and other temporary arrangements and equipment for testing shall be provided by the EC at his cost. Test pressure gauges shall be calibrated by the EC and got approved from EIC.
- 4.3.3 Stacked exchangers shall be hydrotested in stacked conditions.
- 4.3.4 Test pressure shall be as indicated in the name plates mounted on each exchangers. Duration of hydrotest shall be at least one hour. Test pressures and duration of hydrotest may be reduced by EIC. Minimum test water temperature shall be 20°C.
- 4.3.5 Any defects noticed during hydrotesting shall be repaired by EC as per the procedure approved by EIC. Cost for rectifying defects, not attributable to the EC shall be paid separately.
- 4.3.6 No equipment shall in general form part of the piping loop during hydrotesting and shall be blinded off, except when instructed otherwise by EIC.
- 4.3.7 EC to take adequate care during pressurising & depressurising the equipment. EC shall also take care of any instruction given regarding hydrotest in the exchanger drawing.

4.4 Hydrotesting Procedure

- 4.4.1 Shell side & tube side shall be hydrotested separately, unless specified otherwise. If both sides are to be tested together, a warning plate would be fixed to the exchanger, and the instructions given therein are to be followed.
- 4.4.2 The side, shell or tube which ever to be tested at higher pressure shall be taken first.
- 4.4.3 During hydrotest all gasket joints should be checked for any leakage. In case of leakage from any gasket joint, bolting at that joint shall be further tightened following proper tightening sequence (bolts should not be overtightened or tightened by hammering). In case it is not possible to stop leakage by bolt tightening, drain the water in exchanger & replace gasket at that joint by new gasket (gasket will be supplied by owner). After replacing gasket exchanger must be again hydrotested with same procedure to ensure leak tightness.
- 4.4.4 In case of floating head heat exchangers, if it is found during hydrotest that the pressure is dropping, while the external gasketed joints are not leaking, this could be due to floating head gasket joint leakage. This shall be further investigated, by removing shell cover & pressurising tube side to check the floating head gasket joint leakage. In case of leakage observed at floating head flange joint, replace floating head gasket by new gasket. After replacing gasket exchanger must be again hydrotested first on tube side & then on shell side with same procedure to ensure leak tightness of gasket joints.

In case of heat exchangers with shell side hydrotest pressure higher than tube side, it is possible that above procedure (with tube side hydrotest to detect floating head gasket leakage) may not help. Absence of leakage during this test is not conclusive in such a case, as the shell side pressure was dropping during hydrotest. In such a case, floating head gasket shall in any case be replaced and then equipment retested to ensure leak tightness.

4.4.5 When hydrotested as per above procedure after floating head gasket replacement, if it is observed that test pressure is still dropping, this could mean leakage from tube to tubesheet joint. For such cases matter shall be reported to EIC for further investigations/instructions.

4.5 Flushing & Cleaning

4.5.1 After the erection, alignment and grouting of these equipment are complete, and after hydrotest if any, flushing and cleaning shall be carried out by EC as per specifications and instructions of the EIC.

4.5.2 After flushing, cleaning and draining, equipment shall be dried by compressed air at the pressure and for duration decided by EIC. The equipment interior shall be thoroughly inspected to the complete satisfaction of EIC before it is finally boxed up. Boxing up of manholes and handholes shall be leak proof. All joints which need remaking, shall be remade. Compressed air for drying shall be arranged by EC at his cost.

4.6 Inspection and Acceptance Limits for Level & Alignment

4.6.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by EC.

4.6.2 Before equipment are placed on foundations, orientations shall be checked with respect to piping drawings.

4.6.3 When equipment are firmly bolted down but prior to grouting, verticality of all equipment shall be checked by using theodolite. Tolerances for equipment after erection shall be as per EIL Standard 7-12-0001. The allowable deviation from plumb line shall be 1 mm per metre height, subject to maximum of 6 mm.

4.6.4 Horizontal equipment shall be checked for level across machined face of nozzle flanges with precision level.

4.6.5 Difference in elevation of centerline from one end to the other end shall not be more than 1 mm per meter and limited to ± 3 mm maximum. Further elevation difference shall be such as to ensure complete draining of equipment.

4.6.6 Survey of column inside and checking the levelness of support rings, location of bolting bars to ensure that the same are as per column drawings and within tolerances specified in standard 7-14-0001. In case these are not within permissible tolerances, the same shall be reported to EIC for necessary rectification/modification.

4.7 Safety, Health & Environment

EC shall install an exhaust fan for exhaling welding/ cutting fumes etc. and to maintain adequate oxygen level, before any work is started inside confined spaces (i.e. columns). Adequate ventilation shall be maintained at all times. Gas/LPG cylinders shall not be taken inside confined space. When a worker/supervisor enters a confined space, it shall be mandatory to have a second man as standby. Safety belts shall be worn while entering columns, if there is a danger of falling. All ladders/stair cases shall be in place before any item is offered to owner's inspectors. Rope ladders/scaffolding shall be provided inside the column in case tower internals are not easily approachable from column manhole. Low voltage (24 V) lamps equipped with guards shall be used to prevent accidental contact with bulb. All electrical connections shall be through ELCB's and proper earthing shall be ensured. Acids and other materials used for pickling shall be disposed off to a designated place as directed by owner/EIL. All statutory Regulations and owner's safety, health and environment requirements

shall be complied with. Inspection aids for carrying out the inspection of internals shall also be provided.

5.0 ERECTION OF ROTATING EQUIPMENT

5.1 Scope of Work of Erection Contractor

The scope of work shall consist of transportation of Rotating Equipments and accessories from Owner's stores to site, assembly of sub-assemblies/parts, erection of Rotating Equipments on foundations, levelling, aligning and grouting, preparation of Rotating Equipments for trial runs, carrying out no load/trial runs, return of any unused material to the owners stores and hand over in fit condition for the start-up of the Plant, as per instructions of EIC.

Defects due to EC's fault noticed during trial runs shall be rectified by him. Schedule of Quantities, indicate estimated numbers, dimensions and weights of the Rotating Equipments. The actual data on dimensions and weights will be in the vendor data manuals.

The term 'Rotating Equipment' includes all pumps, compressors, steam & gas turbines, fans and blowers, diesel engine/steam turbine/gas turbine generator sets along with drivers accessories & auxiliary systems.

5.2 General Conditions of Erection

5.2.1 All Rotating Equipment erection shall be done by experienced fitters. For this purpose EC shall employ experienced and suitably qualified erection supervisor and crew who have done similar jobs.

5.2.2 The Rotating Equipment manufacturer's instructions as available regarding installation and trial runs will be passed on to EC during the course of work. The requirements prescribed therein shall be met in addition to what is stated in this specification. Erection shall be carried out as per instructions of the Rotating Equipment manufacturer's representative and under their supervision whenever the manufacturer is present at site. In all other cases instructions of the EIC, regarding procedure/sequence of erection shall be binding on EC.

5.2.3 For all Rotating Equipment, EC shall follow the proper sequence for assembly and erection. For Rotating Equipment received along with driver in coupled condition, the coupling bolts shall be dismantled by EC, and alignment shall be rechecked. Realignment, if required, shall be done before recoupling.

Where drivers and couplings are provided separately, drilling and tapping of holes in the base plates for fixing drivers, fixing of couplings on shafts, after enlarging the pilot bores to the correct size with key way etc. and dowelling including provision of dowel pins, alignment screws, jack-up screws or similar arrangements for retaining the alignment shall be carried out by EC as part of erection work. Shims & wedges as required for alignment shall be supplied by EC.

5.2.4 Process and utility (such as cooling water, steam flushing, quenching, lubricating oil, sealing etc.) connections connected with rotating equipment and its auxiliaries shall be fabricated and/or installed by EC from materials supplied by the Owner as per drawings, specifications and instructions of the EIC.

5.2.5 Piping and accessories supplied with the rotating equipment such as seal oil/Gas system, cooling water system & Lube oil system etc. shall be tagged separately and kept in EC's stores till erection. All flanged connections and openings shall be kept blanked with dummies/plugs to prevent entry of foreign matter.

- 5.2.6 The local mounted instruments such as pressure gauges, sight glasses, temperature gauges etc. and Local instrument panels, if any, with necessary connections, shall be installed by EC as part of rotating equipment erection.
- 5.2.7 After initial alignment, the Rotating Equipments shall be properly grouted. Grouting shall be carried out as per this specification. Wherever grout holes are provided in the base plates, grout shall be filled through them also.

Epoxy grout where recommended by the rotating equipment manufacturer, shall be provided by EC and shall be as specified in this standard.

- 5.2.8 Alignment between the Driver and driven equipment shall be done without connecting the equipment nozzles to respective piping. After completion of alignment, the equipment shall be connected to Piping. After the piping has been connected, the alignment shall be re-checked by EC, to ensure that piping connections do not induce any undue stresses on the Rotating Equipments. After making necessary corrections on the piping, if any, re-alignment shall be done by EC and he will ensure that no undue stresses are induced on the Rotating Equipment.

5.3 Special Instructions

EC in addition to general instructions for erection as outlined in para 5.2 above, shall also follow the following special instructions.

5.3.1 Pumps

Depending upon the size of equipment, Pump train will be supplied for erection in any of the following modes :

- (a) Pumps with drivers and accessories fully assembled on a common skid (Base plate).
- (b) Pumps mounted on base plate and couplings and driver supplied loose in separate packs.
- (c) Various major components such as pump, drivers, couplings, gear boxes & base plates auxiliary systems like lube, seal flush equipment in separate packs.

5.3.2 Reciprocating Type Compressors

- 5.3.2.1 Reciprocating compressors may be supplied for erection in knocked down condition in multiple packaged subassemblies such as frame assembly, distance pieces, fly wheels, cylinder block assemblies, valve assemblies etc. and other accessories such as, drivers, couplings, gear boxes (if any), control panels, gauge boards, coolers, lube oil systems, cooling water systems, etc. would be in separate packages.

Besides the above there would be other packages for loose supplied items such as instruments, pre-fabricated piping, and piping/tubing in commercial lengths.

Lifting devices for erection shall be arranged by EC depending on the weight of packages and elevation of installation.

- 5.3.2.2 In case of Rotating Equipments received in knocked down condition, the various parts shall be assembled as per instructions of the EIC and as per manufacturer's instructions. All parts of the Compressor shall be thoroughly cleaned with solvents to remove protective compounds if any, before assembly.

5.3.2.3 The compressor, driver and other accessories shall be erected on their respective foundations and the compressor, couplings, gear box and driver shall be aligned and grouted as per the manufacturer's instructions and instructions of EIC and the manufacturers supervisor (when present). There-after all process and utility, drain & vent connections shall be completed as per the relevant drawings/instructions of equipment manufacturer and advice of EIC.

5.3.2.4 Final alignment shall be done after all the piping connections such as water, steam, drains and connection to coolers etc. are made. Tolerances for alignment shall be maintained as specified in the Manufacturer's Instruction Manual. To ensure that piping connections do not induce any undue stresses on the Rotating Equipment, the alignment shall be checked once again by EC after the piping has been connected. Any correction necessary for proper alignment shall be done by EC.

5.3.2.5 EC shall carefully study the vendor drawings, manuals and other data before start of the job to ensure correct erection, alignment and commissioning.

5.3.3 Centrifugal Compressors & Expanders

5.3.3.1 Centrifugal Compressors are supplied for erection in multiple packages such as,

- Compressor casings
- Drivers (Electrical motors, Steam/Gas turbines - ♦)
{ ♦ : Steam/Gas turbines would be further supplied in multiple packages }
- Base plates (or skids)
- Lube oil/control oil systems
- Sealing systems
- Air filters (for gas turbines & compressors for air service)
- Temporary strainers
- Couplings
- Gear boxes
- Coolers
- Gauge boards
- Control panels
- Lube & Seal Oil tanks
- Fire systems (for gas turbines)
- Condensers (for steam turbines)
- Condensate systems (for steam turbines)
- Loose supply items
- Pre-fabricated & Commercial lengths piping, tubing.
- Other miscellaneous packages

5.3.3.2 Other requirements shall be same as defined in para's 5.3.2.2 to 5.3.2.5 above.

5.4 Trial Runs of Machinery

5.4.1 Any construction defects shall be intimated to EIC before start-up. All protective and safety guards shall be installed and rotating equipment shall be checked for free movement by manual barring over. All foundation bolts and alignment shall be checked before starting the trial runs, if damaged, rotating equipment may have to be opened and repaired as directed by EIC. Prior to carrying out the trial runs, the rotating equipment will be subjected to necessary checks by the EIC and the trial runs shall be commenced only after the approval of the EIC.

- 5.4.2 Unless otherwise specified, all the rotating equipment will be subjected to trial runs for a continuous operation of 72 hours. In case of motor driven rotating equipments, motors shall be decoupled and turned over to other agencies doing electrical work for testing and no load running of motors. After the no load runs of motors are satisfactorily completed, EC shall recouple the motors to the rotating equipment and recheck the alignment. The trial run of the rotating equipment shall be started only after the above is completed. EC shall provide, as part of his work, necessary skilled personnel (excluding the operating personnel) for conducting the trial runs round the clock during the trial runs period. The duration of trial run may be extended if it is considered necessary in the opinion of EIC and EC shall provide personnel for such extended period also. Final inspection of bearing etc. shall be carried out by EC after the Machinery had gone through the trial run and defects, if any, shall be made good for rendering the rotating equipment ready for start up.
- 5.4.3 During the trial runs, readings of bearing temperature, cooling water inlet and outlet temperatures, lube oil inlet/outlet temperature and pressure, rotating equipment discharge pressure and temperature, starting in current, no load/full load current etc. shall be recorded, wherever necessary, by EC. Trial reports shall be prepared in the approved proforma by EC containing all the above details and submitted to the EIC as part of completion documents.
- 5.4.4 EC shall also provide necessary improvised fencing and watch & ward personnel as safety measures during trial runs.

5.5 System Start up

During start-up, EC shall provide necessary skilled personnel as per requirement of EIC, to rectify defects noticed in the rotating equipment, if such defects are attributed to him.

6.0 EQUIPMENT GROUTING

All anchor bolt sleeves/pockets and space under Base plates/machine base frames/shoe plates, etc. shall be grouted with either free flow non shrink cementitious or epoxy grout as per the following categorisation:

Sr. No.	Type of Grout	Application
1	Non shrink cementitious grout	All static and rotating equipments, unless covered in 2) below, viz Static equipments like tall columns, vertical silo, blender etc. and horizontal vessel, drum, sphere, bullets, filter, heat exchangers, coolers etc. and other similar equipments, steel stack/chimney, furnace etc. Low frequency, medium frequency, high frequency rotating machines like compressors (centrifugal, reciprocating, diaphragm, screw, gear type etc.). Induced draft fan, forced draft fan, air blowers, pumps (centrifugal, reciprocating, diaphragm, gear type etc.), expanders, turbine, generator, diesel generator, air coolers (fin fan cooler) and other similar equipment. Machine like screen vibrator, extractor, centrifuge pulverizer, dryer, drop hammer, ball mill, crushers, bagging machine and general workshop equipment.
2	Epoxy grout	Specifically if requested by the Machine Vendor.

6.1 Grout (Material)

All material used for grout shall be in EC's scope. Only approved grout material shall be used. EC shall submit details of grout materials for prior approval of EIC.

6.1.1 Non-Shrink Grout

Non-shrink grout shall be premix type of cementitious (cement pregraded fibre and additive) non-shrink, ready to use grout in dry powder form. It shall have free flow property when mixed with required quantity of water. It shall have initial setting time of 30 minutes.

It shall have the following features:

- Non corrosive to anchor bolts, base plate/saddle/frame, sliding plate.
- Not harmful to concrete and reinforcing steel.
- Non toxic
- Frost, oil and fire resistant
- Require normal curing
- Suitable to use under restraints and grout thickness required
- Expansive to counteract initial shrinkage
- Ensure high early strength without surface crack.
- Suitable for temperature of above 0 deg.C to 200 deg.C.
- Maximum flow distance is compatible to the dimensions of base plate/ saddle/frame.
- It should be resisted to the chemicals, gases etc. being handled in equipment/machines.

It should have the following physical properties:

-	Min. Compressive strength at	3 days	25 N/mm ²
		7 days	30 N/mm ²
		28 days	40 N/mm ²
-	Min. Tensile strength at	28 days	3.5 N/mm ²
-	Min. Bond strength at	7 days	12 N/mm ²
-	Max. Onstrained Expansion in	2 hours	4%
-	Min. Density		2000 kg/m ³

6.1.2 Epoxy Grout

Epoxy grout shall consist of epoxy resin base, hardener and filler component like graded and blended aggregate. Components of epoxy grout shall be of desired grade and mixed in proportion recommended by manufacturer such that it is injectable under base plate/frame/saddle etc., has low viscosity to meet the flow distances according to dimensions of base plate saddle/frame, it is suitable for the desired thickness, it is homogenous, free from segregation, attains high early and high final strength. It shall have minimum Pot life of 30 minutes. It shall have all the features as specified in clause 6.1.1 except for expansive properties.

It should have the following physical properties :

-	Min. compressive strength at	1 day	75 N/mm ²
		7 days	85 N/mm ²
-	Min. Flexural strength	7 days	25 N/mm ²

6.2 Grouting (Placement)

6.2.1 Surface Preparation

Prior to positioning of equipment/machine etc. over concrete pedestal, foundation, slab, beam, etc. all laitance & loose material shall be removed by wire brushing & chipping. The bearing concrete surface shall be sufficiently levelled, hacked with flat chisels to make it rough, clean (using compressed air). Additional chipping, if required, to suit level of base plate and/or minimum thickness of grout shall also be done. In case of use of cementitious grout surface shall be thoroughly wet. All pockets for anchor bolts shall also be similarly cleaned. Any excess water shall be removed. In case of use of epoxy grout, it shall be ensured that surface/pocket to receive grout is totally dry. After erection, alignment/plumbing of equipment/machine in required level, orientation and plumb and installation of sliding plate. Forms shall be constructed around and joints made tight to prevent leakage of the grout.

6.2.2 Preparation of Grout

6.2.2.1 In case of premix type of grout water shall be added in required quantity as specified by supplier and/or EIC. Any specific instruction of manufacturer will be strictly followed.

6.2.2.2 In case of epoxy grout required quantity of all constituents shall be mixed in proportion recommended by manufacturer/supplier and/or EIC. All specific requirements of manufacturer/ supplier shall be strictly followed.

6.2.2.3 Required quantity of grout shall be made considering initial setting/pot life of grout. Any grout not used within initial setting time/pot life shall be rejected and in no case used for grouting.

6.2.3 Placement of Grout

6.2.3.1 Placing of grout shall be taken up only after level, orientation, alignment of equipment/machine has been approved by EIC and anchor bolts are placed in pocket.

6.2.3.2 In case of epoxy grout EC shall give details of grouting scheme and get approval of EIC.

6.2.3.3 The grout mixture shall be poured/injected continuously (without interruption till completion) by grouting pump/injecting gun from one side of base plate and spread uniformly with flexible steel strip and rammed with rods till the space is filled solidly and grout mixture carried to the other side of base plate and fill all pockets. Any specific requirement of manufacturer/supplier shall be strictly followed. Epoxy grout shall be done by or under supervision of manufacturer/supplier and/or agency having adequate experience in this field as per direction of EIC.

Total work shall be done under supervision and direction of EIC and care shall be taken that alignment of equipment/machine is not disturbed.

6.2.3.4 Grout mixture shall be allowed to harden for a period of minimum 7 days or as required by manufacturer/supplier of grout and/or as decided by EIC. At the end of this period, the shims/edges/pack plate may be removed and anchor bolts tightened uniformly. Alignment of equipment/machine shall be rechecked and if found correct, the voids left by the removal of shims/wedges/pack plate (if removed) must be filled up with a similar mixture of grout. In case after checking, serious misalignment is indicated, the grout shall be removed completely and fresh grouting is done after making appropriate correction of alignment.

6.2.3.5 Minimum thickness of grout shall be 25mm for all types of grout and maximum thickness shall be 40mm for non-shrink grout. For epoxy grout the maximum thickness shall be as per manufacturer's recommendation and/or as specified in drawing.

7.0 REFERENCE EIL STANDARDS/ SPECIFICATIONS

6-14-0003	Installation Procedure for Trays & Tower Internals
6-14-0011	Specification for Packing the Column
6-14-0016	Standard Specification for Review of Site Installation of Column Internals.
6-79-0011	Standard Specification for Corrosion Protection Tape Coating for Underground Steel Piping.
6-79-0020	Standard Specification for Surface Preparation and Protective Coating (New Construction)
7-12-0001	Vessel Tolerances.
7-12-0002	Support for Horizontal Vessel
7-12-0003	Wooden Pillow for Saddle Support
7-12-0004	Skirt Base Details
7-12-0024	Lifting Lug Top Head Type
7-14-0001	Construction Tolerance for Welded Supports for Tray / Tower Internals

OBSERVATION ON QUALITY ASPECTS	
Job No: FOI/LOA No: Issued To : M/s	Name of Work: No: Date of Issue:
Location Of Work: Item Of Work:	
Details Of Observation(Deficiency)	Recommended Course Of Action
	Time Allowed For Correction
Issued By: Name : Designation: Signature:	Received by: Name: Signature: Date and Time:
Corrective Action Report By Contractor/Vendor:	
Date:	Name: Signature:
Distribution Before Resolution: RCM/ Area Coordinator /QA Mgr:	
Verification Of Resolution By Issuer/Area Coordinator/RCM(EIL):	
Date:	Name: Signature:
Distribution After Resolution: RCM/ Area Coordinator /QA Mgr:	

OBSERVATION ON SAFETY ASPECTS	
Job No: FOI/LOA No: Issued To : M/s	Name of Work: Date of issue:
Location Of Work: Item Of Work:	
Details Of Lapses/Shortfalls/Hazards Identified	Recommended Course Of Action
	Suspension of work required till resolution. (Yes/No)
	Time Allowed For Correction:
Issued By: Name : Designation: Signature:	Received by: Name: Signature: Date and Time:
Corrective Action Report By Contractor/Vendor:	
Date:	Name And Signature:
Distribution Before Resolution: RCM/ Area Coordinator/QA Mgr :	
Verification Of Resolution By Issuer/Area Coordinator/RCM (EIL):	
Date:	Name: Signature:
Distribution After Resolution: : RCM/ Area Coordinator /QA Mgr:	

Bidder must furnish answers/clarifications/confirmations of all the following queries and submit along with offer.

SL. NO.	COMMENT/QUERY	BIDDER'S CONFIRMATION/ANSWER
1.	Bidder to confirm that requirement of Health, Safety and Environment (HSE) as per specification 6-82-0001 are taken into consideration.	
2.	Bidder to confirm that required construction equipments to meet the contract schedule shall be mobilized by him without any time & cost implications.	
3.	Bidder to confirm that required construction personnel for supervision to meet the contract schedule shall be deployed by him meeting the requirement of qualification and experience (refer Doc. No 7-82-0003 in this regard) without any time & cost implications.	
4.	Bidder to confirm that Construction Management of this job shall be done by him and shall not be sub-contracted to any other agency.	

Bidder's Signature and Stamp	
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1.0 GENERAL

1.1 This technical specification shall be applicable for the work covered by the contract, and without prejudice to the provisions of various international codes of practice, standard specifications etc. It is understood that CONTRACTOR shall carry out the work in all respects with the best quality of materials and workmanship and in accordance with the best engineering practice and instructions of OWNER/authorized representative.

1.2 Wherever it is stated in the specification that a specific material is to be supplied or a specific work is to be done, it shall be deemed that the same shall be supplied or carried out by the CONTRACTOR. Any deviation from this standard without written deviation permit from appropriate authority will result in rejection of job.

2.0 SCOPE

2.1 Scope of work covered in the specification shall include, without being limited to, the following.

2.1.1 This specification defines the requirements for surface preparation, selection and application of primers and paints on external surfaces of CS/MS/LTCS/AS items not in contact with the wheat grains. The items listed in the heading of tables of paint systems is indicative only, however, the CONTRACTOR is fully responsible for carrying out all the necessary painting, coating and lining on external and internal surfaces as per the tender requirement.

2.2 Scope of the work

2.2.1 The following surfaces and materials shall require shop, pre-erection and field painting:

- All structural steel work, pipe, structural steel supports, walkways, handrails, ladders, platforms etc.
- Supply of all primers, paints and all other materials required for painting (other than OWNER/authorized representative supplied materials).
- Repair work of damaged pre-erection/ fabrication and shop primer and weld joints in the field/site before and after erection as required.
- Quality control, testing and inspection during all stages of work (surface preparation, application of coating and testing of furnished coating).

2.2.2 The following surfaces and materials shall not require painting in general. However, if there is any specific requirement by the OWNER/authorized representative, the same shall be painted as per the relevant specifications:

- a. Plastic and/or plastic coated materials
- b. Non-ferrous materials like aluminum and Cu-Ni alloy.

2.3 Unless otherwise instructed, final paint coating (i.e., application of field primer, wherever required, intermediate and top coats) on pre-erection/ shop primed equipment shall be applied at site, **only** after all welding on systems are completed wherever required.

2.4 Changes and deviations, if any, to this specification shall be referred to OWNER/authorized representative.

3.0 REFERENCE CODES & STANDARDS

3.1 Without prejudice to the provision of clause 1.1 above and the detailed specifications of the contract, latest editions of the following codes and standards are applicable for the work covered by this contract.

ISO-12944 : Corrosion protection of steel structures by protective paint system

ASTM-Vol. 6.01&6.03 : American standard test methods for paints and Coatings.

IS-101 : Methods of test for ready mixed paints and enamels

IS-5 : Colour coding

RAL DUTCH : International standard for colour shade (Dutch standard)

3.2 Surface Preparation Standards

The latest editions of any of the following standards shall be followed for surface preparation:

3.2.1 ISO 8501-1 / SIS-05 59 00: ISO standard for Preparation of steel substrates before application of paints and related products. This standard contains photographs of the various standards on four different degrees of rusted steel and as such is preferable for inspection purpose by the OWNER/Authorized Representative.

3.2.2 Steel Structures Painting Council, U.S.A. (Surface Preparation Specifications (SSPC-SP).

3.2.3 National Association of Corrosion Engineers, U.S.A., (NACE).

3.2.4 Various International Standards equivalent to Swedish Standard for surface preparations are given in Table-1.

3.3 CONTRACTOR shall arrange, at his own cost, to keep a set of latest edition of above standards and codes at site.

3.4 The paint manufacturer's instructions shall be followed as far as practicable at all times for best results. Particular attention shall be paid to the following:

a. Instructions for storage to avoid exposure as well as extremes of temperature.

b. Surface preparation prior to painting shall be followed as per Table-3 and 4 of this specification.

c. Mixing and thinning.

d. Application of paints and recommended limit on time intervals in between coats.

4.0 EQUIPMENT

- 4.1 All tools, brushes, rollers, spray guns, blast material, hand power tools for cleaning and all equipment, scaffolding materials, shot and grit blasting equipment & air compressors etc. required to be used shall be suitable for the work and shall be arranged by CONTRACTOR at site and in sufficient quantity. The manufacturer's test certificates / data sheets for all the above items shall be reviewed by OWNER/authorized representative at site before start of work.
- 4.2 Mechanical mixer shall be used for paint mixing operations in case of two pack systems except that the OWNER/authorized representative may allow the hand mixing of small quantities at his discretion in case of specific requirement for touch up work only.

5.0 SURFACE PREPARATION, SHOP PRIMER COATING APPLICATION & REPAIR AND DOCUMENTATION

5.1 General

- 5.1.1 In order to achieve the maximum durability, one or more of the following methods of surface preparation shall be followed, depending on condition of surface to be painted and as instructed by OWNER/authorized representative. Adhesion of the paint film to surface depends largely on the degree of cleanliness of the metal surface. Proper surface preparation contributes more to the success of the paint protective system.
- a. Abrasive blast cleaning
 - b. Mechanical or power tool cleaning
- 5.1.2 Mill scale, rust, rust scale and foreign matter shall be removed fully to ensure that a clean and dry surface is obtained. Unless otherwise specified, surface preparation shall be done as per provisions of relevant tables given in this specification. The minimum acceptable standard, in case of mechanical or power tool cleaning it shall be St. 3 or equivalent. In case of blast cleaning it shall be Sa 2-1/2 as per Swedish Standard SIS-055900 (latest edition) or SSPC-SP or ISO 8501-01. Before surface preparation by blast cleaning, the surface shall be degreased by aromatic solvent to remove all grease, oil etc as per SSPC-SP-01.
- 5.1.3 Irrespective of whether external or internal surface to be coated, blast cleaning shall not be performed where dust can contaminate surfaces undergoing such cleaning or during humid weather conditions having humidity exceeding 85%. In case of internal coating of storage tanks, dehumidifier shall be used, to control humidity level below 60%. Dehumidifier should depress the dew point of air in the enclosed space, sufficient enough so as to maintain it 3°C below the metal substrate temperature during centre period of blasting and coating application. During the interval time between application of primer coat and subsequent intermediate and top coats or between blast cleaning completion and start of application of primer coat, dehumidifier unit should be in continuous operation to ensure that no condensation occurs on substrate.

Dehumidifier should be able to maintain grain drop (moisture removal) at the rate of 25 grains per pound of air per hour. Dehumidifier should have capacity of at least 2 air changes per hour of the enclosed space. All necessary psychometric data should be collected by CONTRACTOR for the given site conditions before starting operation of

dehumidifier to ensure that desired values of dew point, moisture content in enclosed scope is achieved.

Dehumidification to be maintained round the clock for surface preparation and painting till the total coating application is over.

Dehumidifier shall not be stopped under any condition till the entire blasted surface is primed to the satisfaction of the technical representative of the paint manufacturer interested with quality assurance for the work. In case the dehumidifier breaks down in middle of the job, the same shall be replaced at the risk and the cost of CONTRACTOR and the entire unfinished work shall be repeated.

- 5.1.4 OWNER/authorized representative shall have the right to disallow usage of dehumidifier if the performance is not meeting the specified requirements. Under such circumstances CONTRACTOR shall remove the equipment and replace the same with another equipment to provide satisfactory results without any additional cost to the OWNER.
- 5.1.5 Irrespective of the method of surface preparation, the first coat of primer must be applied by airless spray/ air assisted conventional spray if recommended by the paint manufacturer on dry surface. This should be done immediately and in any case within 4 hours of cleaning of surface. However, at times of unfavorable weather conditions, OWNER/authorized representative shall have the liberty to control the time period, at his sole discretion and/or to insist on re-cleaning, as may be required, before primer application is taken up. In general, during unfavorable weather conditions, blasting and painting shall be avoided as far as practicable.

5.2 Procedure for surface preparation

5.2.1 Air blast cleaning with abrasives

The surfaces shall be blast cleaned using one of the abrasives such as Al_2O_3 particles, chilled cast iron or steel grit, copper slag or nickel slag at a pressure of 7.0 kg/cm^2 and at an appropriate distance & angle depending on nozzle size maintaining constant velocity and pressure. Chilled cast iron or steel shall be in the form of shot or grit of size in the range of G16 – G42 conforming to SSPC AB1 and S250 grade size of steel shots (maximum) to obtain a desired surface profile of 35-50 microns trough to peak. For all other abrasives, size shall be in the range of G16 – G24. The combination of steel grits and shots shall be normally in the ratio of 3:1. The quality of abrasives shall be free from contaminants and impurities and shall meet the requirements of SSPC AB1. The compressed air shall be free from moisture and oil. The blasting nozzles should be venturi style with tungsten carbide or boron carbide as the material for liners. Nozzle orifice may vary from 3/16" to 3/4". On completion of blasting operation, the blasted surface shall be clean and free from any scale or rust and must show a grey-white metallic luster. Primer or first coat of paint shall be applied within 4 hours of surface preparation. Blast cleaning shall not be done outdoors in bad weather without adequate protection. If there is dew on the metal surface, it shall be cleaned. The surface profile shall be uniform to provide good adhesion (i.e. 35 to 50 microns) to the paint. If possible, a vacuum collector shall be installed to collect and recycle the abrasives.

5.2.2 Mechanical or power tool cleaning

Power tool cleaning shall be done by mechanical striking tools, chipping hammers, grinding wheels or rotating steel wire-brushes. Excessive burnish of the surface shall be avoided as it can reduce paint adhesion. On completion of cleaning, the detached rust, mill scale etc. shall be removed by clean rags and /or washed by water/steam and thoroughly dried with compressed air jet before application of paint.

5.3 Non-compatible shop coat primer

For equipment on which application of total protective coating (primer + intermediate + top coat) is carried out at shop, compatibility of finish coat with primer should be checked with the paint manufacturer. If the shop coat is in satisfactory condition showing no major defect upon arrival at site, the shop coat shall not be removed.

5.4 Shop coated equipment (coated with primer & finishing coat) should not be repainted unless paint is damaged. Repair shall be carried out as per Table-3 of paint systems depending upon the compatibility of paint.

5.5 Shop primed equipment and surfaces will only be 'spot cleaned' in damaged areas by means of power tool brush cleaning or hand tool cleaning and then spot primed before applying one coat of field primer, unless otherwise specified. If shop primer is not compatible with field primer, then shop coated primer should be completely removed before application of selected paint system for a particular environment.

As mentioned in section 2.4, all coating application at field (field primer, intermediate and top coat) on equipment, structures, piping, etc, shall be carried out only after its erection and all welding, testing (wherever carried out) have been completed.

5.7 Coating procedure and application

All coatings shall be applied by airless spray except for the following special cases, where application can be carried out by brush subject to suitability of the application of the paint product by brush.

- Spot repair
- Stripe coating on edges
- Small bore parts not suitable for spray application

Irregular surfaces such as sharp edges, welds, small brackets, and interstices may stripe coated to ensure specified DFT is achieved. Paint manufacturer recommendation should be followed before deciding for brush application.

5.7.1 Surface shall not be coated in rain, wind or in an environment where injurious airborne elements exist, when the steel surface temperature is less than 5 °F above dew point, when the relative humidity is greater than 85%, when the temperature is below 40°F and when the ambient/substrate temperature is below the paint manufacturers recommended temperature of application and curing. De-humidifier equipment shall be used to control RH and Dew point. The paint application shall not be done when the wind speed exceeds 20 km per hour.

- 5.7.2 Blast cleaned surface shall be coated with complete application of primer as soon as practicable but in no case later than 4 hours the same day.
- 5.7.3 To the maximum extent practicable, each coat of paint shall be applied as a continuous film with uniform thickness and free of probes. Any spots or areas missed in application shall be re-coated and permitted to dry before the next coat is applied. Applied paint should have the desired wet film thickness.
- 5.7.4 Each coat shall be in proper state of cure or dryness before the application of succeeding coat. Material shall be considered dry for re-coating when an additional coat can be applied without the development of any detrimental film irregularities such as lifting or loss of adhesion of the under coat. Manufacturer's instructions shall be followed for inter coat interval.
- 5.7.5 When the successive coat of the same colour have been specified, alternate coat shall be tinted, when practical, sufficiently to produce enough contrast to indicate the complete coverage of the surface. The tinting material shall be compatible with the material underneath and shall not be detrimental to its service life and shall be recommended by the original paint manufacturer.
- 5.7.6 Airless spray application shall be in accordance with the following procedure:

As per steel structure paint manual Vol.1 & Vol.2 by SSPC, USA. Airless spray relies on hydraulic pressure rather than air atomization to produce the desired spray. An air compressor or electric motor, issued to operate a pump to produce pressures of 1000 to 6000 psi paint, is delivered to the spray gun at this pressure through a single hose within the gun. A single paint stream is divided into separate streams, which are forced through a small orifice resulting in atomization of paint without the use of air. This results in more rapid coverage with less over spray. Airless spray usually is faster, cleaner, more economical and easier to use than conventional air spray.

Airless spray equipment is mounted on wheels, and paint is aspirated in a hose that sucks paint from any container, including drums. The unit shall have in-built agitator that keeps the paint uniformly mixed during the spraying. The unit shall consist of in-built strainer. Usually, a very small quantity of thinning is required before spray. In case of high build epoxy coating (two packs), 30:1 pump ratio and 0.020-0.023" tip size will provide a good spray pattern. Ideally, fluid hoses should not have ID less than 3/8" and not longer than 50 ft. to obtain optimum results.

In case of gun choking, de-choking steps shall be followed immediately.

- 5.7.7 Brush application of paint shall be in accordance with the following:
- Brushes shall be of a style and quality that will enable proper application of paint.
 - Round or oval brushes are most suitable for rivets, bolts, irregular surfaces, and rough/ pitted steel. Wide flat brushes are suitable for large flat areas but they shall not have width over 5 inches.
 - Paint shall be applied into all corners.
 - Any runs or sags shall be brushed out.

- e. There shall be a minimum of brush marks left in the applied paint.
- f. Surfaces not accessible to brushes shall be painted by spray, daubers, or sheepskin.

5.7.8 For each coat, the painter should know the WFT corresponding to the specified DFT and standardize the paint application technique to achieve the desired WFT. This has to be ensured in the qualification trial.

5.8 Drying of coated surfaces

5.8.1 No coat shall be applied until the preceding coat has dried. The material shall be considered dry for re-coating when another coat can be applied without the development of any film irregularities such as lifting or loss of adhesion of undercoats. Drying time of the applied coat should not exceed maximum specified for it as a first coat. If this exceeds, the paint material has possibly deteriorated or mixing is faulty.

5.8.2 No paint shall be force dried under conditions which will cause chalking, wrinkling, blistering formation of pores, or detrimentally affect the conditions of the paint.

5.8.3 No drier shall be added to paint on the job unless specifically called for in the manufacturers' specification for the paint.

5.8.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dried to the fullest extent practicable.

5.9 Spot repair of damaged primer

5.9.1 Where pre-erection/shop primer has been damaged at isolated localized spots during handling and transportation or after erection / welding, its repair shall be done as given below and as per the Table-3 of this specification.

5.9.2 Repair of damaged inorganic zinc silicate pre-erection/pre-fabrication/shop primer (F9) after erection / welding in the design temperature of -16°C to 80°C.

Surface preparation: Quickly remove the primer from damaged area by mechanical scraping and emery paper conforming to SSPC-SP-3 to expose the white metal. Blast clean the surface, if possible. Feather the primed surface, over the intact adjacent surface surrounding the damaged area, by emery paper.

Primer coating: One coat of F-9 shall be applied wherever damage was observed on pre-erection / pre fabrication or shop primer of inorganic zinc silicate coating (F-9).

5.9.3 If damaged areas are found to be extensive and spread over large areas, then entire pre-erection/pre-fabrication/shop primer shall be removed by blasting to achieve SSPC-SP-10 and entire blasted surface shall be primed again with F-9, as applicable, for the intended design temperature. (See note under Table-3).

5.10 Paint application

5.10.1 Priming with F9 shall be done only on blasted surface (SSPC-SP-10).

5.10.2 Priming with F9 shall be done only with airless spray.

5.10.3 Assessment of painting requirement

The paint system to be applied for a specific job shall be arrived at sequentially as given below:

- Identify the specific field paint system and surface preparation requirement from this specification.
- Identify the shop priming requirement from based on compatibility of the above paint system.
- Identify the need of repair of shop primer and execute as per Table-3.

5.11 Documentation / records

- 5.11.1 A written quality plan with procedure for qualification trials and for the actual work including test and inspection plan & procedure for approval before start of work.
- 5.11.2 Daily progress report with details of weather conditions, particular of applications, no. of coats and type of materials applied, anomalies, progress of work versus program.
- 5.11.3 Results of measurement of temperatures, relative humidity, surface profile, film thickness, holiday detection, adhesion tests with signature of appropriate authority.
- 5.11.4 Particulars of surface preparation and paint application during trials and during the work.
- 5.11.5 Details of non-compliance, rejects and repairs.
- 5.11.6 Type of testing equipment and calibration.
- 5.11.7 Code and batch numbers of paint materials used.

The coating applicator must maintain a job record consisting of all the information as per 5.11.2 -5.11.7 above as well as the approved procedure of work (5.11.1 above). The job record consisting of information in accordance to 5.11.2 – 5.11.7 shall be entered on daily basis and should be daily signed by Engineer-in-charge.

TABLE-1: SURFACE PREPARATION STANDARDS

Sl. No.	DESCRIPTION	VARIOUS INTERNATIONAL STANDARDS (EQUIVALENT)			REMARKS
		ISO 8501-1/ SIS-05 59 00	SSPC-SP, USA	NACE, USA	
1	Mechanical or power tool cleaning Removal of loose rust loose mill scale and loose paint to degree specified by power tool chipping, de-scaling, sanding, wire brushing and grinding, after removal of dust, surface should have a pronounced metallic sheen.	St.3	SSPC-SP-3	-	This method is applied when the surface is exposed to normal atmospheric conditions when other methods cannot be adopted and also for spot cleaning during maintenance painting.
2	Near white metal Blast cleaning to near white metal cleanliness, until at least 95% of each element of surface area is free of all visible residues with desired surface profile.	Sa 2½	SSPC-SP-10	NACE No. 2	The minimum requirement for polyurethane based and inorganic zinc silicate paints to obtain desired life of paint system.

6.0 PAINT MATERIALS

Typical characteristics of the generic paint products used in this specification and their respective codes are as follows.

TABLE-2: PAINT MATERIALS

Sl. No	DESCRIPTION	F-9	P-6	F-2	F-6 B
1	Technical name	Inorganic zinc silicate coating	Epoxy zinc phosphate primer	Acrylic Polyurethane finish paint	Epoxy-High Build coating
2	Type & composition	A two pack air drying self curing solvent based inorganic zinc silicate coating with minimum 80% zinc content on dry film. The final cure of the dry film shall pass the MEK rub test.	Two component polyamine cured epoxy resin medium, pigmented with zinc phosphate.	Two-pack aliphatic isocyanate cured acrylic finish paint.	Polyamide cured epoxy resin medium suitably pigmented
3	Volume Solids %	60±3	50±1	40 ± 3	60±3
4	DFT (Dry Film thickness) per coat in microns	65-75µ	40-50	30-40µ	100-125µ
5	Theoretical covering capacity in M ² /coat/ litre	8-9	8-10	11-15	5-6
6	Weight per liter in kgs/litre (mix paint)	2.3±0.03	1.4±0.05	1.15±0.03	1.42±0.03
7	Touch dry at 30°C (maximum)	30 minutes.	After 30 min.	30 minutes	3 hrs.
8	Hard dry at 30°C (maximum) Full cure 30°C (for immersion /high temp. service)	12 NA	8 hrs	8 hrs	16 hrs 5 days
9	Over-coating interval	Min.: 12 hrs .at 20°C & 50 % RH	Min.:8hrs.	Min.12 hrs.	Min. Overnight Max. 5 days

10	Pot life at 30°C for two component paints	4-6 hrs.	6 - 8 hrs.	6-8 hrs.	4-6 hrs
11	Temperature Resistance	400 °C Dry service	80°C Dry service	80 °C Dry service min	80°C Dry service

General notes for Table-2:

1. Covering capacity and DFT depends on method of application. Covering capacity specified above is theoretical. Allowing the losses during application, min specified DFT should be maintained.
2. All primers and finish coats should be cold cured and air drying unless otherwise specified.
3. All paints shall be applied in accordance with manufacturer's instructions for surface preparation, intervals, curing and application. The surface preparation, quality and workmanship should be ensured. In case of conflict between this specification and manufacturer's recommendation, the same shall be clarified through OWNER/Authorized Representative.
4. Technical data sheets for all paints shall be supplied at the time of submission of quotations.

7.0 COATING SYSTEMS

The coating system should be selected on the basis as given in the following tables:

TABLE-3: REPAIR OF PRE-ERECTION/PRE-FABRICATION OR SHOP PRIMER AFTER ERECTION/WELDING

Sl. No.	Design Temp. in °C	Surface Preparation	Coating System	Total DFT in Microns (min.)	Remarks
3.1	-16 to 80	SSPC-SP-3	1 coat of F-9	65-75	See note below and clause 5.9.3

General note for Table-3:

1. The application and repair of pre-erection/pre-fabrication or shop primer given in above table shall be done for all the items to be painted. In case the damages of primer are severe and spread over large area, entire primer shall be removed by blasting to achieve SSPC-SP-10 and surfaces to be primed again with F-9 as applicable.

TABLE-4: EXTERNAL COATING SYSTEM FOR ALL CS/MS/AS/LTCS STRUCTURAL ITEMS

Sl. No.	Design Temp. in °C	Surface Preparation and primer	Coating System	Total DFT in Microns (min.)	Remarks
4.1	-16 to 80	SSPC-SP-10; 1coat of F-9 @ 65-75µ DFT/coat	1 coat of P-6 @40 µ + 1 coat of F-6B@ 100 µ + 1 coat of F-2 @ 40µ DFT/coat	225-255	No over- coating over F-9 is allowed

8.0 STORAGE

- 8.1 All paints and painting materials shall be stored only in rooms to be arranged by contractor and approved by Engineer-in-charge for the purpose. All necessary precautions shall be taken to prevent fire. The storage building shall preferably be separate from adjacent building. A signboard bearing the word "PAINT STORAGE – NO NAKED LIGHT – HIGHLY INFLAMABLE" shall be clearly displayed outside. Manufacturer's recommendation shall be followed for storage of paint materials.

9.0 COLOUR CODING

Colour coding shall be followed as per the OWNERs discretion.

10.0 QUALITY CONTROL, INSPECTION AND TESTING

- 10.1 All painting materials including primers and thinners brought to site by contractor for application shall be procured directly from manufactures as per specifications and shall be accompanied by manufacturer's test certificates.
The painting work shall be subject to inspection by Engineer-In-Charge at all times. In particular, following stage-wise inspection will be performed and contractor shall offer the work for inspection and approval of every stage before proceeding with the next stage. The record of inspection shall be maintained in the registers. Stages of inspection are as follows:

- Surface preparation
- Primer application
- Each coat of paint

10.2 During surface preparation, following tests are to be carried out:

- Test for presence of oil/grease and contamination

The steel substrate after degreasing as per SSPC-SP 1 shall be tested as per following procedure to validate absence of oil and grease contamination.

- Visual inspection - Continue degreasing until all visible signs of contamination are removed.
- Conduct a solvent evaporation test by applying several drops or a small splash of residue-free tri-chloromethane on the suspect area especially pitting, crevice corrosion

areas or depressed areas. An evaporation ring formation is indicative of oil and grease contamination.

Continue degreasing and inspection till test is passed.

- Tests for surface finish of blasted surface shall be done by visual inspection using SSPC-VIS1. Clear cellophane tape test as per ISO 8502-3 shall be used to confirm absence of dust on blasted surface. Checks shall be done on each component at least once per 200 m² of blasted surface and minimum of 3 checks per shift.
- Test for presence of soluble salt as per method ISO 8502-9. Maximum allowable salt content shall be considered 20 mg/m². Checks shall be done on each component at least once per 200 m² of blasted surface and minimum of 3 checks per shift. In case salt exceeds specified limit, the contaminated surface shall be cleaned by method as per Annexure-C of IS 12944-4 (water cleaning). After cleaning surface shall be retested for salt after drying.

- Blast Profile Measurement:

The angular profile depth measurement shall be done by profile tape as per method NACE Standard RP 0287 or ASTM D 4417 method B (Profile depth gauge micrometer). Spot measurement shall be carried out every 15m² of blasted surface. At each spot three measurements shall be taken over an area of 10 cm² and average of measurements to be recorded and reported.

If profile is <65 microns blasting shall continue till greater than 65 microns depth profile is achieved.

- Tests for blasting media, blasting air

Blasting Media (For every fresh batch of media and one random test during blasting)

Blasting Media shall be visually inspected for absence of contamination and debris using 10 X magnification.

- a) Inspection for the absence of oil contamination shall be conducted using following procedure:

- Fill a small clean 200 ml bottle half full of abrasive.
- Fill the bottle with potable water, cap and shake the bottle.
- Inspect water for oil film/slick. If present, the blasting media is not to be used.

- b) Soluble salt contamination if suspected shall be verified by method ASTM D 4940. If present, media to be replaced.

- c) Clean blasting equipment, especially pot and hoses, and then replace blasting media and retest.

Test for Blasting Air (Once Daily before start of blasting and once at random during blasting)

The air for blasting shall be free from moisture and oil. The compressor air shall be checked for oil and water contamination per ASTM D 4285.

In addition to above, record should include type of shop primer already applied on equipment e.g. zinc silicate.

Any defect noticed during the various stages of inspection shall be rectified by the contractor to the entire satisfaction of Engineer-In-Charge before proceeding further. Irrespective of the inspection, repair and approval at intermediate stages of work, contractor shall be responsible for making good any defects found during final inspection/guarantee period/defect liability period as defined in general condition of contract. Dry film thickness (DFT) shall be checked and recorded after application of each coat and extra coat of paint should be applied to make-up the DFT specified without any extra cost to owner, the extra coat should have prior approval of Engineer-in-charge.

10.3 Primer Application

After surface preparation, the primer should be applied to cover the crevices, corners, sharp edges etc. in the presence of inspector nominated by Engineer-In-Charge.

The shades of successive coats should be slightly different in colour in order to ensure application of individual coats, the thickness of each coat and complete coverage should be checked as per provision of this specification. This should be approved by Engineer-In-Charge before application of successive coats.

The contractor shall provide standard thickness measurement instrument with appropriate range(s) for measuring dry film thickness of each coat, surface profile, gauge for checking of surface profile in case of sand blasting, holiday detectors and pinhole detector & protector whenever required for checking in case of immersion conditions.

Prior to application of paints on surfaces of chimneys, the thickness of the individual coat shall be checked by application of each coat of same paint on M.S. test panel. The thickness of paint on test panels shall be determined by using gauge such as 'Elko meter'. The thickness of each coat shall be checked as per provision of this specification. This shall be approved by Engineer-In-Charge before application of paints on surface of chimney.

At the discretion of Engineer-In-Charge, the paint manufacturer must provide the expert technical service at site as and when required. This service should be free of cost and without any obligation to the owner, as it would be in the interest of the manufacturer to ensure that both surface preparation and application are carried out as per their recommendations. The contractor is responsible to arrange the same.

10.4 Final inspection of finished coating shall consist of measurement of:

- 1) Paint dry film thickness (DFT)
 - 2) Adhesion
 - 3) Holiday detection check as well as for finish and workmanship.
- 1) **Coating DFT** measurement shall be as per ISO 2808. Type II electromagnetic gauges should be used for ferrous substrates. DFT gauge calibration, number of measurement shall be as per SSPC-DA 2. Measured DFT shall be within + 10% of the dry film thickness, specified in the specifications.
 - 2) **Adhesion** of the primer to the steel substrate and inter-coat adhesion of the subsequent coat(s) after curing for at least a week after application of the topcoat shall be examined by a knife test in accordance with ASTM D 6677. For the knife test, if the rating is better than 8, the adhesion is considered acceptable. The adhesion is

destructive and tested areas shall be repaired afterward using the spot repair procedure. Alternatively, the applicator may perform the adhesion test on a steel panel coated using the same surface preparation and coating application procedure as the work piece. Adhesion testing shall be carried out for each component at least once per 200 m² (2000 ft²) of coated surface.

- 3) **Holiday testing** shall be conducted in accordance with NACE SP 0188. For immersion services, 100% of coated area shall be inspected for holidays. For atmospheric exposure, 10% of coated area which must include weld seams, corners and edges to be holiday tested. Voltage at which test is to be carried out will depend upon DFT of coating being tested and shall be as per NACE SP 0188. Any holiday is unacceptable and should be marked and repaired immediately.

The contractor shall arrange for spot checking of paint materials for Specific gravity, glow time (ford cup) and spreading rate.

10.5 Final Inspection of coating system

A final inspection shall be conducted prior to the acceptance of the work. The coating contractor and the facility owner shall both be present and they shall sign an agreed inspection report. Such reports shall include:

General

- Names of the coating contractor and the responsible personnel
- Dates when work was performed

Coating Materials

- Information on coating materials being applied
- Condition of coating materials received

Environmental Conditions

- Weather and ambient conditions
- Coating periods

Surface Preparation

- Condition of surface before preparation
- Tools and methods used to prepare surface
- Condition of surface after preparation

Coating Application

- Equipment used
- Mixing procedure prior to application
- Coating application techniques used

Testing

- Type and calibration of inspection instruments used.
- Type of quality control tests performed, and results.

11.0 GUARANTEE

The contractor shall guarantee that the chemical and physical properties of paint materials used are in accordance with the specifications contained herein/to be provided during execution of work.