

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery		
	CLIENT		INDIAN OIL CORPORATION LIMITED		
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003		Rev. No. 0	Page 1 of 22

STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY

0	02.12.2019	ISSUED FOR IMPLEMENTATION	TB	PKP /LA	LA	JMC
REV.	DATE	STATUS	PREPARED	CHECKED	APPROVED	AUTHORISED

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 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
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STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 2 of 22

TABLE OF CONTENTS

1	SCOPE	3
2	ABBREVIATIONS & DEFINITIONS.....	3
3	GENERAL	3
4	PREPARATION FOR ERECTION	4
5	ERECTION OF MECHANICAL EQUIPMENT COLUMNS, TANKS, VESSELS AND DRUMS ETC.....	4
6	QUALITY PROCEDURE FOR – EQUIPMENT ERECTION -STATIC.....	9
7	HEAT AND MASS TRANSFER EQUIPMENT	11
8	INSPECTION AND ACCEPTANCE LIMITS FOR LEVEL & ALIGNMENT	17
9	SAFETY, HEALTH & ENVIRONMENT	17
10	ERECTION OF ROTATING EQUIPMENT	17
11	QUALITY PROCEDURE FOR – EQUIPMENT ERECTION -ROTARY	20

 		PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
		CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY		Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 3 of 22

1 SCOPE

This specification covers technical requirements for erection of all static and rotating equipment by CONTRACTOR at site.

2 ABBREVIATIONS & DEFINITIONS

“OWNER or IOC or IOCL or CLIENT” shall mean INDIAN OIL CORPORATION LIMITED

“CONSULTANT or PMC” shall mean TECHNIP INDIA LIMITED.

“CONTRACTOR” shall mean the bidder selected by the OWNER for performing the scope of works specified in the bid documents.

“AUTHORISED REPRESENTATIVE” shall mean OWNER's/CONSULTANT's representative authorized to act for and on behalf of OWNER/CONSULTANT, as the case may be

“VENDOR” shall mean any third party selected by either the OWNER or CONTRACTOR for supplying any of the equipment/materials for the Unit specified in the bid documents.

“PROJECT” shall mean Sulphur Recovery Unit and Additional tanks Project, Paradip Refinery

“UNIT” shall mean the totality of the units and facilities comprised in the Scope of work, which forms a distinct operating system.

“SUB- CONTRACTOR” shall mean Sub -Contractor engaged by CONTRACTOR

3 GENERAL

3.1 CONTRACTOR shall prepare erection scheme and rigging procedure and obtain approval from Owner /PMC.

3.2 All necessary handling equipment, tools, tackles and precision instruments for carrying out the works as specified shall be arranged by the CONTRACTOR.

3.3 Equipment Manufacturer's recommendations regarding preservation during storage at site and detailed specifications for the installation along with layout drawings, general arrangement/equipment outline drawings and sub-assembly drawings of the various equipment and machinery shall be prepared by CONTRACTOR.

3.4 Erection shall be carried out as per the instructions and supervision of Equipment / Machinery manufacturer's representative, wherever such supervisory services are applicable.

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 4 of 22

4 PREPARATION FOR ERECTION


- 4.1 CONTRACTOR shall be responsible for organizing 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.
- 4.2 Rigging procedure for all the major lifts (above 20 MT) and at maximum crane capacity shall be submitted by CONTRACTOR for the approval of Owner/PMC. However, approval to rigging procedure proposed by CONTRACTOR shall not relieve CONTRACTOR from his responsibility in following the proper lifting/erection methods on ensuring orderly
- 4.3 Orientation of all foundations, elevations, length and disposition of anchor bolts and diameter of holes in the supports saddles shall be checked by CONTRACTOR, well in advance. Minor rectifications including chipping of foundations shall be carried out by CONTRACTOR.
- 4.4 CONTRACTOR shall crosscheck such piping and structural drawings with actual construction at site and in case of any mismatch CONTRACTOR shall carryout rectification after getting approval from Owner/PMC before taking up the erection.
- 4.5 The presence of Vendor representatives may be required for installation and pre-commissioning of equipment to be assembled on site.
- 4.6 It is essential to follow the manufacturer specialist's detailed instructions, in order to adapt the present document to the specific requirements of each equipment.
- 4.7 If necessary, the rust preventive protection shall be renewed on flanges, according to Specification:080557C-000-PP-807 Instructions for Material Handling & storage procedure.
- 4.8 All the surfaces liable to be deteriorated by corrosion will be frequently checked and painted, if necessary.
- 4.9 Conservation and maintenance records, issued for each item by warehouse maintenance team, will be filled-in also during erection.
- 4.10 All the routine checks must be recorded, dated and signed.

5 ERECTION OF MECHANICAL EQUIPMENT COLUMNS, TANKS, VESSELS AND DRUMS ETC

- 5.1 Scope of work of CONTRACTOR not limited to
 - 5.1.1 Preparation of erection scheme and rigging procedure and obtaining its approval from Owner /PMC

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 5 of 22

- 5.1.2 CONTRACTOR shall be responsible for receiving, Inspection ,storing, Preservation, unloading of all items including free issue items at site, transportation of Equipment and accessories from CONTRACTOR's store / Owner's store to site at the location as identified by CONTRACTOR within the designated plot, Making roads for transportation of equipment & crane access, erection of Equipment on foundations, levelling ,aligning and grouting, welding (if applicable) ,erection of internals ,testing, flushing & cleaning, pre-commissioning, commissioning and handing over to Owner as per instructions of PMC at site.
- 5.1.3 All cranes as required for unloading of these free issues shall have to be arranged by the CONTRACTOR. All the encumbrance in the path of movement.
- 5.1.4 CONTRACTOR to provide necessary assistance to ODC supplier during unloading activities and also required to assist removal of the ODC trailers of ODC consignments if any shall have to be removed by the CONTRACTOR.
- 5.1.5 Upon receipt, Equipment shall be checked for any damages as a result of transport, handling and defects, if any, shall be reported to the PMC. Rectification /replacing of defects shall be carried out in accordance with approved procedure
- 5.1.6 CONTRACTOR scope includes supply of foundation bolts, nuts, foundation templates and structural and levelling material as required for erection and installation of structure, equipment as designated in the tender package.
- 5.1.7 All equipment/machinery erection shall be done by experienced fitters. For this purpose, CONTRACTOR shall employ an experienced erection supervisor and crew who have done similar jobs.
- 5.1.8 Assembly and fixing of demisters, grids, internal distributors and other internal fittings in Columns, Vessels etc.
- 5.1.9 Filling of Columns, Reactors, Vessels/Drums etc. with Raschig rings, supporting elements, sand, concrete etc. as required.
- 5.1.10 Welding of washers for equipment, erection of pipe davit & minor welding of their parts as per specifications and instruction of PMC.
- 5.1.11 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 PMC.
- 5.1.12 Flushing, cleaning and drying of Columns, Vessels/Drums etc
- 5.1.13 Completing the equipment in all respects for commissioning the plant as per drawings, specifications & instructions of PMC at site.

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 6 of 22

5.1.14 Any modification in the erected Columns, Reactors, Vessels/Drums to the complete satisfaction of Owner /PMC

5.1.15 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.

5.2 General Conditions of Erection

5.2.1 Vessels which are partially or completely fabricated, or field assembled, shall follow the same assembling and construction as they are constructed in shop.

5.2.2 Before starting field assembling, verify that WPS, PQR procedure are approved by PMC.


5.2.3 Field fabricated vessels shall be hydrostatically tested in operating position according to applicable code.

5.2.4 Before performing the hydrostatic test check if the foundation design has taken in consideration the load of vessel full of water.

5.2.5 Rigging procedures and erection schemes for all the heavy lifts weighing 20 MT & above shall be prepared by CONTRACTOR and got approved by PMC. Approval by PMC shall not relieve CONTRACTOR 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 neighboring 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 PMC, erection of such equipment shall not be undertaken in any case by CONTRACTOR.

5.2.6 While handling, transporting or erecting the equipment, care shall be taken not to damage the nozzles, instrument connections, structural clips etc. CONTRACTOR 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 PMC before actual erection is started.

5.2.7 CONTRACTOR 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 CONTRACTOR at his cost, as and when required by PMC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by CONTRACTOR at his cost. Tested slings will be punched for test loads and date of testing as directed by PMC.

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 7 of 22

5.2.8 Foundations

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 equipment. Line (orientation) and levels are to be marked on all the foundations to facilitate checking of alignment.

Check the anchor bolts location, elevation and size prior of setting equipment on the foundations & Confirm, in particular, that the anchor bolts have not been cut and welded or heated and bent.

Mark setting level on foundation blocks versus bench mark and project level:

One point on the perimeter for foundations up to diameter 3 m, two opposite points on the perimeter for foundations over diameter 3 m.

Mark foundations axes: N/S and E/W.

If the foundations are in reinforced concrete, prepare the upper surface of the concrete to receive grout after vessel erection. Then, chip the upper concrete surface until to obtain a required clearance between coarse aggregate and vessel base plate

Clean the concrete surface by a clean sweep or blowing compressed air in order to eliminate all dirt and other loose material.

Install steel levelling plates near all foundation bolts on rough concrete level. The maximum/minimum height for shimming should be 60/25 mm from rough concrete level.


Check their setting level and horizontality as soon as the shim plates have been installed.

The levelling steel plates shall be installed at least seven days before equipment erection.

The equipment shall be shimmed with flat steel plates placed on the concrete. Plates or shims shall be placed at each side of all anchor bolts and under other parts of the base carrying loads so that the base shall be properly supported.

5.2.9 After having performed the above-mentioned activities, the foundation can be released for erection.

5.2.10 Place the equipment on the foundation block without damaging the threads of the foundation bolts, and check the equipment orientation according to the drawings.

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 8 of 22

- 5.2.11 Check that the location of the equipment axes in comparison with the location specified on the drawings and the elevation of shims in comparison with the elevation specified on the drawings and marked on foundations.
- 5.2.12 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 CONTRACTOR. After the level, alignment and verticality etc. are checked and approved by PMC, CONTRACTOR shall carry out grouting.
- 5.2.13 Ladders, platforms, walkways shall be correctly installed with handrails, and flooring shall be properly secured.
- 5.2.14 CONTRACTOR 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. 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. 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 PMC.
- 5.2.15 CONTRACTOR shall execute assembly & erection of agitator/mixer along with drive unit including all accessories as per supplier's instructions, specification drawings & instructions of PMC at site.
- 5.2.16 Flushing & Cleaning of Columns, Vessels, Drums etc.
- 5.2.17 After the erection, alignment and grouting of this equipment are complete, flushing and cleaning shall be carried out by CONTRACTOR as per specifications and instructions of Owner/PMC at site.
- 5.2.18 After flushing, cleaning and draining, equipment shall be dried by compressed air at the pressure and for duration decided by the PMC. The Vessel interior shall be thoroughly inspected to the complete satisfaction of Owner/PMC before it is finally boxed up. Boxing up of manholes and hand holes shall be leak proof. All joints which need remaking, shall be remade. Compressed air for drying shall be arranged by CONTRACTOR.
- 5.2.19 Unless otherwise specified, all the instruments such as pressure gauges, sight glasses temperature recorders etc. including instrument panels, if any, shall be installed by CONTRACTOR as part of Equipment erection.


 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 9 of 22

5.3 Inspection and Acceptance Limits for Level and Alignment


- 5.3.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by CONTRACTOR.
- 5.3.2 Before equipment are placed on foundations, orientations shall be checked with respect to piping drawings.
- 5.3.3 When equipment is 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 PDRP-8430-SP-0007 The allowable deviation from plumb line shall be 1 mm per meter height, subject to maximum of 15 mm unless otherwise stated on the drawings.
- 5.3.4 Horizontal Vessels shall be checked for level across machined face of nozzle flanges with precision level.

6 QUALITY PROCEDURE FOR – EQUIPMENT ERECTION -STATIC

- 6.1 CONTRACTOR shall prepare Quality plan, ITP & related procedures and get approval from Owner /PMC to ensure consistent and comprehensive compliance to project specifications during Static Equipment erection work.
- 6.2 The following activities to be carried out by CONTRACTOR not limited to
- 6.2.1 Prior to the commencement of the work, CONTRACTOR will review the latest revisions of the applicable drawings, specifications, codes and material lists. This review is to ensure complete understanding of the processes to be implemented, to yield a product compliant with the contract requirements
- 6.2.2 The Quality Plan shall cover the testing requirements for each in-process activity as required per specification.
- 6.2.3 The equipment shall be checked for compliance with the latest/final Seller documentation.
- 6.2.4 Static equipment members will be received and installed based on the tag numbers per the Data sheets & drawings as applied at the Seller shop. Upon receipt, they shall be checked for damage.
- 6.2.5 Preservation/maintenance of static equipment (e.g. N2 Purge) shall be performed in accordance with the Seller recommendations and per agreed procedure.
- 6.2.6 Templates for static equipment anchors shall be used.

 		PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
		CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY		Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 10 of 22

- 6.2.7 Upon receipt, throughout storage and until commissioned, the protective covers shall be kept intact.
- 6.2.8 Prior to onsite installation of the equipment, preparations shall be completed.
- 6.2.9 The foundations shall be scrapped, anchor bolts protected and foundations accepted.
- 6.2.10 The proper rigging equipment shall be prepared. Plan for the lifting shall be reviewed and setting of equipment ensured.
- 6.2.11 In the case of heavy (or complex or extended reach) lifting, the CONTRACTOR shall prepare and have approved in writing by OWNER/ PMC, a lifting plan as described in the HSE requirements.
- 6.2.12 The foundation orientation (0°, 90°, 180°, 270°) shall be marked prior to setting the equipment.
- 6.2.13 Equipment nozzle orientation shall match foundation orientation & Equipments shall be installed in the correct orientation and alignment.
- 6.2.14 Shims of proper material and in proper positions shall be installed and surveyed prior to setting the equipment.
- 6.2.15 Field installation shall be inspected and documented per the approved ITP for Erection of Equipment –Static.
- 6.2.16 The Tag number of the equipment shall be verified before setting.
- 6.2.17 Anchor bolts shall be snug tight.
- 6.2.18 Equipment shall be set level, plumb and in the correct orientation, within the tolerances. 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
- 6.2.19 After the piping has been connected, the alignment shall be checked by CONTRACTOR again, to ensure that piping connections do not induce any undue stresses on the Equipment. After making necessary corrections on the piping, if any, realignment shall be done by CONTRACTOR to ensure that no undue stresses are induced on the equipment.
- 6.2.20 The foundation shall be prepared for grouting (e.g. soaking for recommended period).
- 6.2.21 Grouting shall be performed per Seller recommendations/instructions/ Project Specification and the approved ITP for Grouting works (after ensuring the type of grout is correct).
- 6.2.22 Final anchor bolt tightening shall be performed.



 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 11 of 22

- 6.2.23 Installation of equipment internals shall be performed in accordance with Seller's requirements and the applicable project specifications and drawings.
- 6.2.24 The equipment shall be opened and the shop installed internals checked (remove temporary transport supports if any)
- 6.2.25 The tightness and the levelness of trays shall be verified.
- 6.2.26 Field installed internals shall be installed per specification and Seller requirements.
- 6.2.27 Field closure of internal manways shall commence after inspections have been completed.
- 6.2.28 Equipment shall be labeled/tagged per requirements.
- 6.2.29 Loading of packing and/or catalyst shall be performed in accordance with Seller's instructions and project specifications and drawings.
- 6.2.30 Specified materials for loading shall be inspected and monitored throughout the loading process.
- 6.2.31 Depths of layers shall be ensured and accepted by the parties involved.
- 6.2.32 Painting, insulation & fireproofing where specified shall be carried out in accordance with the applicable specifications attached in the tender document.
- 6.2.33 A release as to the final closing of the equipment shall be initiated.
- 6.2.34 Before the release will be signed, all final closure materials shall be at the installation point(s), e.g. gaskets, bolting, tensioning/tightening tools etc.
- 6.2.35 Final punch listing will consider cleanliness, completion of installation works and QC documentation completion.
- 6.2.36 Each installation, maintenance and inspection shall be recorded on the applicable forms as noted on the approved ITP for Static Equipment Erection work and related ITP's.
- 6.2.37 All non-conformances are recorded and reported to the Owner / PMC for disposition.



7 HEAT AND MASS TRANSFER EQUIPMENT

7.1 Scope of work of CONTRACTOR not limited to


- 7.1.1 Preparation of erection scheme and rigging procedure and obtaining its approval from Owner /PMC.

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 12 of 22

- 7.1.2** CONTRACTOR shall be responsible for receiving, unloading of all items including free issue items like (Long Lead Items) at site and at the location as identified by CONTRACTOR within the designated plot. All cranes as required for unloading of these free issues shall have to be arranged by the CONTRACTOR. All the encumbrance in the path of movement.
- 7.1.3** Upon receipt of Equipment shall be checked for any damages as a result of transport, handling and defects, if any, shall be reported to the PMC. Rectification /replacing of defects shall be carried out in accordance with approved procedure.
- 7.1.4** CONTRACTOR scope includes supply of foundation bolts, nuts, foundation templates and structural and levelling material as required for erection and installation of structure, equipment as designed in the tender package.
- 7.1.5** 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.
- 7.1.6** Supply of necessary shims, levelling plates, wedges, sliding base plate.
- 7.1.7** Erection on foundations including aligning, levelling and grouting.
- 7.1.8** All equipment/machinery erection shall be done by experienced fitters. For this purpose, CONTRACTOR shall employ an experienced erection supervisor and crew who have done similar jobs.
- 7.1.9** 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.
- 7.1.10** Installation of transformers on desalters (if any) and their electrical connection to electrode grid etc.
- 7.1.11** Welding of chimney trays, lattice girders, beams etc. wherever required.
- 7.1.12** Hydrotest shall be carried out at site (in addition to shop hydrotest) after installation to take care of leakages during handling in shipping. Procedure is given in para 7.10 below. CONTRACTOR to note that any equipment which are refractory lined at shop shall not be hydrotested.
- 7.1.13** Carrying out minor adjustments, modifications, seal welding of seal plates etc. wherever necessary during installation.
- 7.1.14** Assembly and fixing of demisters, grids, internal distributors and other internal fittings in Columns, Vessels etc.



 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 13 of 22

- 7.1.15 Checking of installed trays & tower internals.
- 7.1.16 Filling of Columns, Reactors, Vessels/Drums etc. with Raschig rings, supporting elements, sand, concrete etc. as required.
- 7.1.17 Welding of washers for equipment, erection of pipe davit & minor welding of their parts as per specifications and instruction of PMC.
- 7.1.18 Flushing, cleaning and drying of equipment using compressed air and blinding to prevent ingress of rain, dust etc.
- 7.1.19 Installation of refractory lining, brick lining, ceramic boards etc., as per specifications, recommendations of manufacturer and instructions of PMC at site.
- 7.1.20 Mounting of instruments like safety valves, rupture disks, sight glasses etc. as required.
- 7.1.21 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 PMC at site.
- 7.1.22 Completing the equipment in all respects for commissioning the plant as per drawings, specifications & instructions of PMC at site.
- 7.1.23 Any modification in the equipment to the complete satisfaction of PMC
- 7.1.24 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.
- 7.2 General Conditions of Erection**
- 7.2.1 CONTRACTOR shall prepare & submit the rigging procedure to Owner/PMC for approval.
- 7.2.2 The rigging procedure shall include the following as a minimum:
- 7.2.3 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 neighboring 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 Owner /PMC, erection of equipment shall not be undertaken in any case by the CONTRACTOR.
- 7.2.4 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


 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 14 of 22

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 PMC before actual erection is started.

- 7.2.5** After erection, the equipment shall be levelled and properly aligned with necessary shims and wedges supplied by CONTRACTOR. After the level, alignment and verticality etc. are checked and approved by Owner / PMC then CONTRACTOR shall carry out grouting.
- 7.2.6** CONTRACTOR 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 CONTRACTOR at his cost, as and when required by the Owner/PMC. The weights of test loads shall be as per IS-807. The test loads shall be supplied by CONTRACTOR at his cost. Tested slings will be punched for test loads and date of testing as directed by PMC.
- 7.2.7** CONTRACTOR 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 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. 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 Owner /PMC
- 7.2.8** CONTRACTOR shall install base plate over the sliding end foundation before erection of shell and tube exchangers
- 7.2.9** Levelling and plumpness shall be approved by Owner /PMC and shall be checked using theodolite before grouting and final finishing of the foundations. The record of the same shall be maintained.
- 7.2.10** CONTRACTOR to ensure that shell and tube exchangers shall be firmly bolted down to foundations at the fixed end. Further CONTRACTOR to ensure that foundation bolts at the sliding saddle end are at the center 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.
- 7.2.11** CONTRACTOR shall ensure that no equipment is subjected to any corrosion during all stages work till handing over to OWNER.
- 7.2.12** In case the shell and tube exchangers are to be stacked, but have been stored as single shells at the store, then CONTRACTOR shall erect the bottom most shell, then erect other shell(s) sequentially using the nozzle gaskets/bolting and saddle bolting. Additional shims, if necessary, shall be supplied & Installed by EC. If the exchangers do not have interconnecting nozzles, then nozzle elevations shall be maintained as per piping GAD.

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 15 of 22

- 7.2.13** All equipment, consumable and other accessories required for completion of the job shall be arranged by the CONTRACTOR. 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.
- 7.2.14** For bought out items like plate exchangers, plate fin exchangers, electric heater, etc. vendor's instructions shall be followed
- 7.2.15** CONTRACTOR shall check the health of the equipment refractory lined at shop on receipt and shall report any defect or damage in the same to PMC. During installation, all precautions shall be taken to avoid any damage to refractory lining. Any damage to refractory during erection shall be repaired by CONTRACTOR without loss of time.
- 7.2.16** 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.
- 7.3** Hydrotesting of shell and tube exchangers including condensers
- 7.4** 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 PMC. For exchangers fitted with SS bellow or SS part, potable water with max. 25 ppm chlorides shall be used for hydrotesting.
- 7.5** 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 CONTRACTOR at his cost. Test pressure gauges shall be calibrated by the CONTRACTOR and got approved from PMC
- 7.6** Stacked exchangers shall be hydrotested in stacked conditions.
- 7.7** Test pressure shall be as indicated in the name plates mounted on each exchanger. Duration of hydrotest shall be at least one hour. Test pressures and duration of hydrotest may be reduced by PMC. Minimum test water temperature shall be 20°C.
- 7.8** No equipment shall in general form part of the piping loop during hydrotesting and shall be blinded off, except when instructed otherwise by PMC
- 7.9** CONTRACTOR to take adequate care during pressurizing & depressurizing the equipment. CONTRACTOR shall also take care of any instruction given regarding hydrotest in the

 		PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
		CLIENT	INDIAN OIL CORPORATION LIMITED		
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003		Rev. No. 0	Page 16 of 22


exchanger drawing.

7.10 Hydrotesting Procedure

- 7.10.1** 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.
- 7.10.2** The side, shell or tube which ever to be tested at higher pressure shall be taken first.
- 7.10.3** 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 shall be supplied by CONTRACTOR). After replacing gasket exchanger must be again hydrotested with same procedure to ensure leak tightness.
- 7.10.4** In case of floating head heat exchangers, if it is found during hydrotest that the pressure is dropping, while the external gasket joints are not leaking, this could be due to floating head gasket joint leakage. This shall be further investigated, by removing shell cover & pressurizing 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
- 7.10.5** 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.
- 7.10.6** 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 tube sheet joint. For such cases matter shall be reported to PMC for further investigations/instructions.

7.11 Flushing & Cleaning

- 7.11.1** After the erection, alignment and grouting of these equipment are complete, and after hydrotest if any, flushing and cleaning shall be carried out by CONTRACTOR as per specifications and instructions of the PMC at site.
- 7.11.2** After flushing, cleaning and draining, equipment shall be dried by compressed air at the pressure and for duration decided by PMC. The equipment interior shall be thoroughly inspected to the complete satisfaction of PMC 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 CONTRACTOR.

 	PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
		CLIENT	INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 17 of 22

8 INSPECTION AND ACCEPTANCE LIMITS FOR LEVEL & ALIGNMENT

- 8.1 Co-ordinates of foundations/supporting structures/mounting holes etc. shall be checked with respect to the plot plans by CONTRACTOR.
- 8.2 Before equipment are placed on foundations, orientations shall be checked with respect to piping drawings.
- 8.3 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 PDRP-8430-SP-0007. The allowable deviation from plumb line shall be 1 mm per meter height, subject to maximum of 6 mm.
- 8.4 Horizontal equipment shall be checked for level across machined face of nozzle flanges with precision level.
- 8.5 Difference in elevation of centerline from one end to the other end shall not be more than 1mm per meter and limited to ± 3 mm maximum. Further elevation difference shall be such as to ensure complete draining of equipment.
- 8.6 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 PDRP-8430-SP-0007.


9 SAFETY, HEALTH & ENVIRONMENT

- 9.1 CONTRACTOR shall install an exhaust fan 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 /PMC. 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/PMC. All statutory Regulations and owner's safety, health and environment requirements shall be complied.

10 ERECTION OF ROTATING EQUIPMENT

10.1.1 Scope of Work of CONTRACTOR

- 10.1.2 The scope of work shall consist of receiving, Inspection, storing, preservation, transportation

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 18 of 22

of Rotating Equipment and accessories from CONTRACTOR' stores / Owner's stores to site, assembly of sub-assemblies/parts, erection of Rotating Equipment on foundations, levelling, aligning and grouting, preparation of Rotating Equipment for trial runs, carrying out no load/trial runs, Pre-commissioning & commissioning, performance run & handing over to Owner, as per instructions of PMC at site.

10.1.3 The presence of Vendor representatives may be required for installation and pre-commissioning of equipment to be assembled on site.

10.1.4 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.

10.2 General Conditions of Erection

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



10.2.2 Erection shall be carried out as per instructions of the Rotating Equipment manufacturer's representative and under their supervision whenever the manufacturer present is required at site.

10.2.3 For all Rotating Equipment, CONTRACTOR 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 CONTRACTOR, and alignment shall be rechecked. Realignment, if required, shall be done before recoupling.

10.2.4 Where drivers and coupling's 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 CONTRACTOR as part of erection work. Shims & wedges as required for alignment shall be supplied by CONTRACTOR.

10.2.5 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 as per drawings, specifications and instructions of the PMC at site.



10.2.6 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 CONTRACTOR stores till erection. All flanged connections and openings shall be kept blanked with dummies/plugs to prevent entry of foreign matter.

 		PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
		CLIENT	INDIAN OIL CORPORATION LIMITED		
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0		Page 19 of 22

- 10.2.7 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 CONTRACTOR.
- 10.2.8 After initial alignment, the Rotating Equipment shall be properly grouted. Grouting shall be carried out as per specification. Wherever grout holes are provided in the base plates, grout shall be filled through them also.
- 10.2.9 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 CONTRACTOR, to ensure that piping connections do not induce any undue stresses on the Rotating Equipment. After making necessary corrections on the piping, if any, re-alignment shall be done by CONTRACTOR and ensure that no undue stresses are induced on the Rotating Equipment.
- 10.2.10 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 PMC and. There-after all process and utility, drain & vent connections shall be completed as per the relevant drawings/instructions of equipment manufacturer and advice of PMC.
- 10.2.11 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 CONTRACTOR after the piping has been connected. Any correction necessary for proper alignment shall be done by CONTRACTOR.

10.3 Trial Runs of Machinery

- 10.3.1 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.
- 10.3.2 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 equipment, motors shall be decoupled and carry out no load running of motors. After the no load runs of motors are satisfactorily completed, CONTRACTOR 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. The duration of trial run may be extended if it is considered necessary in the opinion of PMC. Final inspection of bearing etc. shall be carried out by CONTRACTOR after the Machinery had gone through the trial run and defects, if any, shall be made good for rendering the rotating equipment ready for startup.

 	PROJECT		Standby SRU & Additional Tanks IOCL Paradip Refinery	
	CLIENT		INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 20 of 22

10.3.3 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 by CONTRACTOR. Trial reports shall be prepared in the approved format by CONTRACTOR containing all the above details and submitted to the PMC as part of completion documents.

10.3.4 CONTRACTOR shall also provide necessary improvised fencing and watch & ward personnel as safety measures during trial runs.

10.4 Equipment grouting

10.4.1 Equipment grouting shall be carried out as per Specification of Grouting 080557C-000-JSS-1700-004.

11 QUALITY PROCEDURE FOR – EQUIPMENT ERECTION -ROTARY

11.1 CONTRACTOR shall prepare Quality plan, ITP & related procedures and get it approval from Owner /PMC to ensure consistent and comprehensive compliance to project specifications during Static Equipment erection work.

11.2 Reference to API 686 Recommended Practice for Machinery Installation and Installation Design shall be followed.

11.3 The following activities to be carried out by CONTRACTOR not limited to

11.3.1 Prior to the commencement of the work, CONTRACTOR will review the latest revisions of the applicable drawings, specifications, codes and material lists. This review is to ensure complete understanding of the processes to be implemented, to yield a product compliant with the contract requirements


11.3.2 The Quality Plan shall cover the testing requirements for each in-process activity as required per specification.

11.3.3 The equipment shall be checked for compliance with the latest/final Seller documentation.

11.3.4 Rotating equipment members will be received and installed based on the tag numbers per the Data sheets as applied at the Seller shop. Upon receipt, they shall be checked for damage.

11.3.5 Preservation/maintenance of rotating equipment shall be performed in accordance with the Seller recommendations and per agreed procedure.

11.3.6 Templates for rotating equipment anchors shall be used.

 		PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery	
		CLIENT	INDIAN OIL CORPORATION LIMITED	
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 21 of 22

- 11.3.7 Upon receipt, throughout storage and until commissioned, the protective covers shall be kept intact.
- 11.3.8 Prior to onsite installation of the equipment, preparations shall be completed.
- 11.3.9 The foundations shall be scrapped, anchor bolts protected and foundations accepted.
- 11.3.10 The proper rigging equipment shall be prepared. Plan for the lifting shall be reviewed and setting of equipment ensured.
- 11.3.11 In the case of heavy (or complex or extended reach) lifting, the CONTRACTOR shall prepare and have approved in writing by OWNER/ PMC.
- 11.3.12 The foundation orientation (0°, 90°, 180°, 270°) shall be marked prior to setting the equipment.
- 11.3.13 Equipment nozzle orientation shall match foundation orientation & Equipment shall be installed in the correct orientation and alignment.
- 11.3.14 Shims of proper material and in proper positions shall be installed and surveyed prior to setting the equipment.
- 11.3.15 Field installation shall be inspected and documented per the approved ITP for Erection of Equipment –Rotary.
- 11.3.16 The Tag number of the equipment shall be verified before setting. Check centerline and nozzle elevations after setting
- 11.3.17 Connect the space heaters as required.
- 11.3.18 Rough alignment shall be performed after the equipment anchor bolts are snug tightened.
- 11.3.19 The foundation shall be prepared for grouting (e.g. soaking for recommended period)
- 11.3.20 Grouting shall be performed per Seller recommendations/instructions and the Specification for Grouting works (after ensuring the type of grout is correct).
- 11.3.21 Alignment shall be carried out in sequence per Seller's recommendation and/or project specifications.
- 11.3.22 Alignment with and without coupling shall be performed, piping not connected.
- 11.3.23 Adjoining piping shall be tested, aligned and connected to the equipment with no stress induced (observe dials while tightening flange bolts).
- 11.3.24 Final alignment shall be performed

 		PROJECT	Standby SRU & Additional Tanks IOCL Paradip Refinery		
		CLIENT	INDIAN OIL CORPORATION LIMITED		
STANDARD SPECIFICATION FOR ERECTION OF EQUIPMENT & MACHINERY	Project No. 080557C001	Document No. 080557C-000-JSC-0000-003	Rev. No. 0	Page 22 of 22	

11.3.25 Installation shall be finalized.

11.3.26 Lubrication materials shall be obtained per the applicable lubrication list.

11.3.27 Lubricants shall be applied to the required levels.

11.3.28 Final punch listing will consider Final punch listing will consider cleanliness, completion of installation works and QC documentation completion.

11.4 Documentation

11.4.1 Each installation, maintenance and inspection shall be recorded on the applicable forms as noted on the ITP for Rotating Equipment installation work and related ITP's.

11.4.2 All non-conformances are recorded and reported to the Field Engineer for disposition.